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Microscopical Analysis

ON account of the amount of space required in this issue for the articles on the engineering works of San Francisco, it has been necessary to hold out the fourth article of Mr. Johnson's series on the microscopical examination of concrete. It will appear in next week's issue.

The Engineer's Exposition

Engineers have in a way a special claim on the Panama-Pacific Exposition, which opens on the date of this issue. It is in a sense their exposition, in that it chronicles not an historical fact, as did the Chicago and St. Louis fairs, but the completion of a monumental engineering work. It would show a lack of appreciation of the object of the Panama work to hold that the exposition was wholly for the glorification of the Isthmian achievement as an engineering enterprise. The end is greater than the means, and in its full sense the San Francisco exposition celebrates the revolution of commercial routes, the joining of our coasts by water, and all that the new waterway means to the commerce of the whole world. Nevertheless, there is no escape from the fact that essentially the canal is an engineering enterprise. Engineers, therefore, should feel a special interest in the exposition, even if the character of the exhibits, which are especially strong technically, and the International Engineering Congress did not make a direct appeal for their attendance. It is not inappropriate, too, to point out that the exposition does credit to the work it celebrates by being done on time—thus breaking all exposition records. For these reasons the Engineering Record devotes this issue to San Francisco's engineering works, and to other Coast matters—to tell engineers some of the things they may expect to see on a trip to the Coast, in addition to the exposition.

Edison Fire Report

THE joint report of the National Board of Fire Underwriters of the National Fire Protection Association, printed in part on page 239 of this issue, is a document meriting the closest study by the civil engineer. With ample time at their disposal, the investigators have found interesting evidences of the effect of what may be termed "wholesale" expansion, that is, expansion throughout the whole length of long structures. The effects of such expansion have never before, to the knowledge of this journal, been so carefully observed. Their avoidance, it would seem, depends not so much on changes in the design of the concrete as on the division of the structures by transverse fire walls and the provision of other means to prevent the spread of fire. The explanations of the failures of wall columns and for the cracking off of corners are very plausible. That for the latter phenomenon is particularly illuminating, for under the theory that the initial failure was due to the expansion of the rods it was impossible to explain corner destruction where bars had not been exposed. The report emphasizes, what has already been brought out, that the round column has the greater fire-resistance, while thicker protection is recommended for the lower flanges of beams and girders. On one point, the reported fusion of the concrete, the Engineering Record believes that further data are needed. The report of the Bureau of Standards on this matter will be eagerly awaited. Observations have convinced this journal that the action was chemical, aided, of course, by the intense heat. All in all, the report is a most unusual document and too much credit cannot be given its authors, particularly Ira H. Woolson, who wrote the section on the effect of the fire on the concrete.

Sewage Aeration Experiments

TO the careful reader of the British technical papers it is apparent that in sanitary engineering the treatment of sewage by aeration has been the subject of transcendent interest in England during the past year. From the tone of various papers by competent English authorities it is fair to assume that if marked developments are shortly to be made in sewage treatment it will be along these lines. In this country the subject has not been neglected. Probably the best known work is that of Prof. Earle B. Phelps and Col. William M. Black at Brooklyn, in connection with the study of New York Harbor pollution, and of H. W. Clark and his associates at the Lawrence Experiment Station. A further study of this important subject is now assured by the announcement that the U. S. Public Health Service and the Baltimore Sewerage Commission are to co-operate in a series of experiments to be conducted at the Baltimore works. Professor Phelps and Calvin W. Hendrick have given this journal a brief outline of the proposed investigations. Recent English results seem to supplement the Brooklyn work and to explain certain irregularities which interfered with its complete success. It is proposed, therefore, to elaborate the earlier experiments, making use of the activated sludge principle developed by the English workers. Leslie C. Frank will represent the Public Health Service and have charge of the experiments. One of the Imhoff tanks, recently completed, will be slightly modified so that it can be used to test the effect of aeration upon a practicable scale and also reproduce the continuous flow process, which is essential if practical use is to be made of the English principle. Sanitary engineers will take a keen interest in these tests and the Public Health Service and the Baltimore Sewerage Commission are to be congratulated on undertaking the experiments.

Plain vs. Reinforced Sections

IN balancing the cost of alternative designs, whether in the mind of the engineer or by carefully comparing detailed drawings, the relative cost of construction due to apparently small causes is often the item in which a surprise develops. A cause which often contributes to this is the unexpected difficulty with which unskilled labor accomplishes the minor arrangements that are all too easily laid out in the plans. For example, in constructing concrete sewer pipe in Vancouver, B. C., where day labor is paid $3 per eight hours, cement costs $2.40 per barrel, and reinforcing bars $60 per ton, it has developed that reinforced-concrete sewer pipe, designed for very slight pressure, and a plain concrete monolithic sewer of twice the thickness can be constructed at the same cost. In other words, it is as cheap to put in 100 per cent more concrete as it is to get the steel properly arranged in the lighter pipe and work the concrete around it. This has been shown by an elaborate system of segregated cost accounts, which takes careful note of each part of the work. Of course, if the sewer diameter be small enough so that pipe is cast in sections in a yard and transported to the work, the additional cost of handling heavier units would have to be added to the cost of plain concrete pipe. However, it is ordinarily found economical, under conditions in Vancouver, to pour concrete pipe in place in the trench until the diameter becomes as low as 30 in. For pipe about three feet in diameter it is found that the sewer can be cast monolithic at about 70 per cent of the labor cost required in casting unit lengths in a pipe yard and joining these in the trench.

Ten Years of Concrete Progress

IT was appropriate, indeed, that the presidential address before the American Concrete Institute last week should be on the progress in concrete during the ten years of the association's existence; appropriate, too, that the review should have been made by one who has been most intimately connected with the affairs of the institute and of the advancement of the art through the whole period. In 1904 the production of Portland cement was 26,500,000 barrels while in 1914 it had reached 88,500,000, with a peak production (in 1913) about three and a half million barrels in excess of the 1914 figures. Mr. Humphrey points out that the setback is but temporary, and that at the end of the present acute business depression the production curve will start upward at a slope that will soon place it even with the mark it would have reached had the business of the last few years been normal. As to variety of uses, the progress has been no less remarkable and in one field, especially, such as to exceed the rosiest expectations of the promoters. In 1910 only half a million barrels were used in road and pavement work. In two years the total had risen to nearly two million barrels, while in 1914, despite the retrogression in total production, four and a half million barrels went into roads and pavements. What the future will bring no one can say, but it is to be expected that the increase in production will be at an accelerating rate for many years, due to the efforts of the cement companies to make their product a material of everyday use—as distinguished from an engineering material. In this broadening propaganda some companies have already achieved a notable success, much to the advantage of those farmers and farming communities which have taken the lead. Mr. Humphrey's chief prediction was that a satisfactory concrete railroad tie would eventually be developed, a prediction for whose realization railroad men will eagerly hope, provided, of course, that it represents economy over present practice. There is, indeed, reason for satisfaction over the history of these past ten years. Opposition to the material has been largely overcome, and the fundamental requisites for the making of good concrete firmly established. The era of failures and of unsatisfactory work is now largely by, marking progress beyond the early development stage. Much remains to be done, chiefly by way of refinement, and the virility and progressiveness of those responsible for the past ten years of achievement are fully equal to the task.

Future Progress

PROGRESS in concrete has, however, resulted in putting many of those interested in and responsible for its advances in a complacent mood—or rather in a mood to resent any suggestions regarding the improvement of concrete or of the manufacture and uses of cement which come from those not intimately connected with the industry. It is proper that charlatans be frowned on, but the present disposition of many, particularly those connected with cement manufacturing companies, is dangerous to the future progress of the art. These remarks are prompted, primarily, by the character of criticism in some quarters against the articles on the use of the microscope in concrete, now being published in this journal. Criticism is invited, and in fact Mr. Johnson has made it clear that much is to be learned regarding the investigations he is making. For that reason he has emphasized the simplicity of the methods and urged their wide application, so that their full value and application may be determined as quickly as possible. In some quarters, however, it has been felt that these articles are detrimental to the interests of cement manufacturers, and they have, accordingly, been met with derision, the stock weapon of the ignorant. Much of the same disposition cropped out when the autoclave test for cement was proposed; and though against the claims then made were the experiences of twenty years ago in Germany with the same method, its frank consideration was calculated to stimulate discussion as to those factors which might result in greater uniformity in cement. Progressive cement men have since acknowledged that while they disagreed with the publicity methods employed in connection with that test, the discussion had been beneficial to the industry and had resulted in improving the quality of the product. The cement industry is too big to be satisfied with anything but the best, and while it cannot be expected that it will accept upon first announcement any proposed improvement in manufacture or use, its own best interests require that every proposal, honestly made after due study and thought, be given fair consideration. The industry will be the chief gainer from any real advances, and advances will come more rapidly if new ideas are received with an open mind.

Rebuilding San Francisco

GREAT fires have swept over cities before, and the engineer has ever been an important factor in the reconstruction that followed, but the case of San Francisco is unique both because of local conditions and because modern engineering skill has never had greater opportunity to show what improvements and safeguards can be provided in a complete reconstruction on the old site. Sweeping 4 sq. mi. in the business center of the city, the fire of 1906 not only facilitated the prompt carrying out of such projects as municipal tunnels, a civic center and a high pressure water supply system, but also stimulated many civic improvements not directly affected, such as a new source of water supply, interurban transportation, port improvement and many other projects mentioned in the general review of San Francisco's engineering works that appears on page 222 of this issue.

It is most interesting to compare the proportions of class A, B and C structures built since the fire, and to note that although it is obviously impossible for a designer to make provision for shocks and stresses of whose magnitude and duration he has no foreknowledge whatever, it is common practice in San Francisco to give some consideration to the effect of possible future seismic disturbances. Not much attention is paid to this question in designing the ordinary office building on good foundation, it is true, but in the case of a tall, slender structure, the designs are subjected to an investigation as to what would happen if a shock equal to that of 1906 should recur. Thus the 6 ft. per second acceleration of that quake has become a sort of standard for comparison. It is to be noted, however, that the catastrophe of 1906 was 10 per cent earthquake and 90 per cent fire, and that the most careful thought of all has been put on the new fire protection system, which, with its cistern and salt water emergency sources for use if the usual supply should fail, is a marvel of efficiency and dependableness.

The engineer who visits San Francisco this year will find there much food for thought in the many problems that simultaneously confronted the city and have not yet been finally settled, as they have in most eastern centers of greater age. The question of relieving traffic congestion on Market Street, which the converging streets on the north will always intensify, is one of great importance that must be answered soon, while the recent successes of the Municipal Railways make it evident that the city must buy the property of the local street railway company or make some provision for relieving its present condition. Furthermore, there is a proposal under consideration to purchase the $37,000,000 Spring Valley water-supply system and to develop partially a daily supply of 400,000,000 gal. to be brought through a 145-mile aqueduct. A 2-mi. tunnel is being built in the city under a 1000-day contract, and the question of how to dispose of garbage most economically will have to be worked out very soon.

These are only a few of projects under way or in prospect that constitute the daily routine of the city engineer's office, and it is a significant fact that in the past year the San Francisco Board of Works called on the engineering department for estimates on over $9,000,000 worth of proposed municipal work, in addition to that which was later approved for construction.

However, in spite of the wide variety and the importance of these many municipal projects, there is one paramount problem which underlies and affects all the others, but which has not yet been fought out and decided one way or the other. This is the question of a greater San Francisco. Sooner or later it must be a leading issue and there will be presented, no doubt, a plan for the advantageous co-operation of all the related cities in the Bay region.

A Notable Committee Work

NOTABLE, indeed, was the action of the council of the American Society of Mechanical Engineers last Saturday in approving the report of its boiler code committee, for in importance and in time spent it ranks with the best committee work of American technical societies.

The work was originally undertaken over three years ago, on Sept. 15, 1911, under instructions "to formulate standard specifications for the construction of steam boilers and other presure vessels and for the care of same in service." The importance of the step is apparent when one considers that there is no uniformity in State boiler laws, and that, despite State enactments, there are between 1300 and 1400 serious boiler accidents per annum, in which from 400 to 500 persons are killed and 700 to 800 injured. The property loss is over $500,000.

Seven members, a consulting engineer, former member of the Massachusetts Board of Boiler Rules; two professors of engineering, two boiler manufacturers and an insurance engineer, composed the committee. The Massachusetts and Ohio rules, believed to be the best in use, were taken as a basis. After modification, effected in numerous committee meetings, a preliminary draft was prepared and circulated among those believed to be interested. The suggestions resulting were carefully studied and, as a next step, public hearings, bringing together engineers, representatives of steel manufacturers, of the railways and of boiler manufacturers, were held in New York in September and October, 1914. The fruitfulness of these hearings is worthy of comment. Agreement was reached on uniform specifications for boiler steel and boiler tubes, and on uniform rules for safety valves, fire-tube and water-tube boilers and steam and hot-water heating boilers. The suggestions made were then thoroughly digested, the tentative code revised, again printed and distributed.

Again there was revision before the draft (the fourth to be put into type) was sent to the membership, prior to the annual meeting of December, last year. So deep was the interest, so important the questions, that six sessions, aggregating twenty hours of sitting, were held. An unusual volume of valuable criticism was received, and so urgent was the interest of the boiler manufacturers, who were most willing from the start to accept more rigid rules than then obtained, even more stringent than those of Massachusetts, that it was decided shortly after the annual meeting to make the final revisions while the suggestions were clear in the members' minds. Speed was all the more important because several State legislatures had held proposed boiler-code action in abeyance until advantage could be taken of the society's work. Accordingly, an advisory group of eighteen members was appointed to sit with the committee and assist it in putting the code into practicable form. The work was begun Dec. 15 and was continued without interruption for six weeks.

It is apparent, therefore, that the best thought of the mechanical engineering profession and of the industry has been given the document now approved by the society's council. It will be given weight accordingly. Very wisely the committee has been continued, in order that, as the art develops and experience accumulates, the needed amendments may be made.

The history of this work has been cited in some detail so that ample credit, through full understanding of the extent of the labors, may be given the society for its work. All investigations in engineering lines redound sooner or later to the public good, but the bearing of a boiler code on the public welfare is immediate. Activities such as these lay the public under heavy obligation to those willing to make the sacrifices, and while the man in the street will not know that he is indebted to the society, thoughtful members of the community must eventually learn of such activities, and the society, accordingly, be given more and more recognition as a factor in the Nation's life.

The "Jitney" Bus

LIKE wildfire there has swept through the West in the last three months a development in interurban traffic handling, the "jitney", that needs the careful consideration of municipal engineers. While the reason for its spread has been the desire for engaging in a, presumably, profitable business, the engineer must approach the subject from a different angle. What, is his question, is the effect of the new service on the efficiency of passenger handling, on street congestion, on safety on the streets?

Many readers will not know what a "jitney" is. The term is used to describe auto-buses or itinerant automobiles, carrying passengers for a 5-cent fare upon any temporary route that seems likely to produce profits. The expression "jitney" is said to be the side-show barker's slang for a 5-cent piece. Three months ago the name was hardly known outside its place of origin, Los Angeles. The idea has now spread from Los Angeles to San Francisco, Seattle and other Coast cities, to Texas and even as far east as Detroit and Toledo. In some cases the jitneys are owned by companies, which operate a fleet of buses or of automobiles, but generally the cars are run by their owners.

The experiences of various cities which the jitney has invaded do not indicate that the innovation will reduce street congestion —the chief concern, with reference to it, of the municipal engineer—nor that the streets will be as safe as in the past. These conclusions, in fact, might have been predicated on a mere consideration of the factors involved. The larger-size buses, measuring 17 to 18 ft. in length and 6 or 7 ft. in width, hold only one-eighth the number of passengers of the average-size street car in use in American cities. In other words, eight such buses are needed to do the work of one street car, and occupy as much space as three such cars. Apparently, then, the jitney does not offer a solution of the congestion problem, and, from the municipal engineer's standpoint, fails in the direction to which chief importance has been attached.

As to safety, testimony is unanimous from the cities concerned that the jitney has caused an increase in accidents and must be put under stringent control.

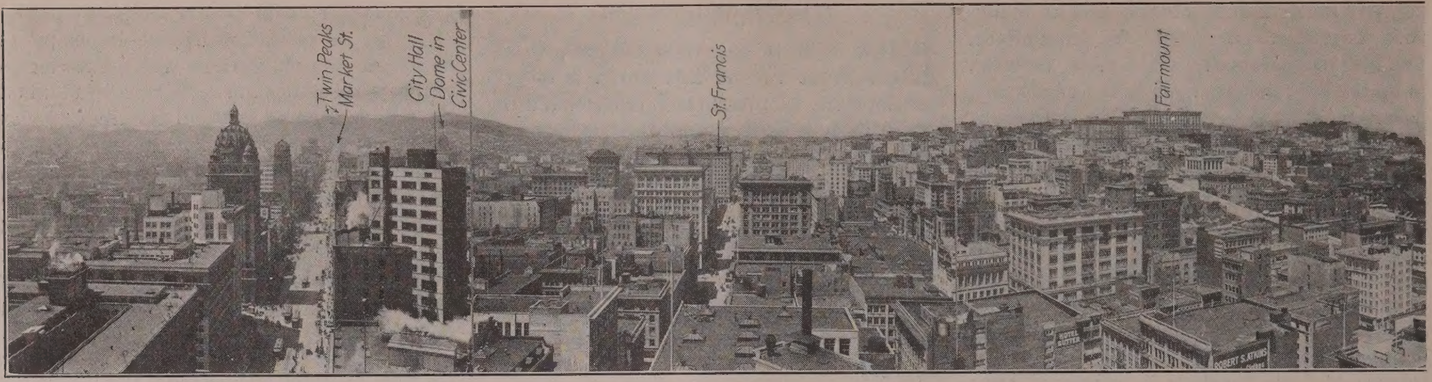
These reasons alone—increase of congestion and menace to pedestrians—are sufficient to justify restriction on the growth of the movement. But there are other effects, not so immediately the concern of the municipal engineer, that demand careful consideration, and, in the judgment of this journal, require the adoption of measures which will prevent injustice being done the constituted agencies for intra-urban transportation. The jitney has been allowed to become a direct competitor of the electric railways, which, of their very nature, are monopolistic, at least as to given routes. Aside from the impossibility of laying additional tracks it is unthinkable that rival street railway companies should operate on the same street. Yet the condition is paralleled by giving the jitney the privilege of the street, without—and this is most important—imposing on the latter the obligations which the electric railway must assume. The railway must, on public demand, extend its lines to new and undeveloped territory, it must operate certain lines at a loss, and expect to make up the deficit on profitable routes. The jitney has no such obligations. It takes only the cream, operates only on busy routes, invades only the territory which the street railway has gone to the expense of developing. The municipality has an obligation, none the less solemn and binding because implied, to protect the profitable routes for those who have covenanted to operate those that result in loss as well as those that yield an adequate return.

Other considerations, in the way of taxes paid, pavements laid and maintained, transfers given, bring additional evidence of the injustice done the electric railways.

It will be objected to this line of argument that if the jitney is fundamentally a more economical method of transportation, it must eventually prevail, such regulations as to safety and avoidance of congestion being imposed. This cannot be denied. But by this test, the jitney again fails, indicating that this mushroom growth will soon disappear. It need not be demonstrated to the engineer that isolated power plants, such as the jitneys represent, are less economical than the large stations customary on electric railways, unless the isolated plants have extraordinary high efficiencies. Experience with automobile operating costs fails to show such extraordinary economy. Comparisons of upkeep of equipment and labor charges per passenger will also show to the disadvantage of the jitney.

But if such be the case, why has the movement spread? Are the pioneers engaging in a losing venture? Analysis shows such to be the case. The owners of the jitneys are apparently doing a profitable business, but they are now carrying operating charges only. If they set aside reserves for depreciation, repairs and renewals, and charge interest on their investment, the gilt-edge appearance of the enterprise will disappear. Most of the operators will not expect to get back interest charges, and, leaving this out, the operating cost of a Ford car making 100 miles per day has been figured at 7 cents per mile or \$7 per day. If the trips average 2½ miles each and four passengers are carried at each trip the receipts would be \$8 per day, but it is practically impossible to operate at this high "efficiency of use". Trips with less than four passengers and idle time will bring the receipts below the expenses.

It is probable, therefore, that the jitney has not come to stay, and that its days will be very brief if it is put under regulations comparable to those of its competitor, the street railway. Auto-bus transportation in this country is not an experiment, but only lines that have charged a 10-cent fare have survived. It is not to be expected that the jitney will be able to alter this record.



THE NEW SAN FRANCISCO—LOOKING UP MARKET STREET FROM THE HOBART BUILDING, 315 FEET HIGH

A New San Francisco Has Risen from the Ruins of 1906

Unique Problems Solved and Construction Records Broken in Building a More Modern and Safe City—The Catastrophe Expedited Many Civic Plans—Exposition Ready on Time for World's Inspection

NO one who looked upon the hopeless ruin in the wake of earthquake and fire in San Francisco 9 yr. ago could have predicted a rapid recovery from such overwhelming loss, and even those optimistic enough at that time to look forward to complete rehabilitation of the city and its commerce allowed many years for its accomplishment. However, so powerful have been the influences at work that in less than a decade the metropolis of the western coast is not only entirely restored, but has taken advantage of the clean sweep of the fire to institute advanced plans, such as the Civic Center, which were not feasible before, and to cap the climax now "invites the world" to an exposition which in itself represents the work of several years.

In the three-day fire that followed the earthquake 28,000 buildings were burned and in 497 city blocks or 4 sq. mi. of the most valuable parts of the city only a few charred landmarks remained. It was feared that the moral effect of this would be a discouragement to be reckoned with just as certainly as the financial and commercial setback, but a negative answer to this fear appears in a report of Bion J. Arnold written as long ago as March 1913, in which he states: "A careful analysis of growth shows that the loss in population due to the fire has been more than made up; that the growth of San Francisco is now more rapid than ever, and that a city of 1,000,000 inhabitants will have to be provided for within 25 to 40 yr. or less."

Building Reconstruction

While it is true that the earthquake demolished many poorly constructed buildings and more or less severely wrecked some of the better class structures, the total earthquake damage was almost insignificant in comparison to the devastation wrought by the fire that followed. Thus the resultant effect upon the design of buildings appears to have been slight. The need for metal window sash and trim has been emphasized, reinforced concrete has gained in favor and the advantage of riveted steel over bolted steel frames has become more apparent. Filled ground near the city waterfront is not now considered a good location for high structures unless they are built on deep pile foundations.

Unfortunately no reinforced-concrete buildings, with one exception, had been erected prior to the fire, but in those structures where steel columns were encased in concrete there was but little damage to the structure itself, while similar buildings with tile around steel columns did not withstand the fire test. For purely local reasons prior to the fire, brick was the preferred building material, but it was clearly demonstrated that this construction is less stable than concrete in walls because of the jarring loose of the bricks when the wall tends to rock. It is worth while, however, to note that a number of class A buildings stood structurally intact after the fire, though gutted of interior finish. Some of those that survived and are in service today are the Call, Shreve, St. Francis, Monadnock and Wells Fargo buildings.

The earthquake of 1906 had an acceleration of 6 ft. per second, and structural engineers now point out that if of short duration this is not a serious shock for class A buildings on a good foundation with proportionally large base area and properly designed for a 30-lb. wind. This wind load is that usually assumed in San Francisco on the ordinary office buildings. A radical change has come about in recent years, however, in the design of tall, slender structures such as chimneys or stand pipes. Steel or concrete is the only material now recommended for such work, and it is customary to design for a brief shock with the 6-ft.-per-second acceleration. But this does not impose extraordinary restrictions on the design, for even in the taller chimneys of heavy section erected in San Francisco it seldom exceeds the equivalent of a 100-lb. wind pressure.

The accompanying panorama of the business district, taken on Jan. 15, 1915, from the Hobart building, presents pictorially the extent of the reconstruction in an area that was so completely wiped out by fire in 1906 that scarcely a score of buildings remained in the entire range of this photograph. To tell the same story in figures is to say that the total value of structures in San Francisco for which the Board of Public Works issued permits between the fire of 1906 and Jan. 1, 1915, is $263,351,669. This total value was apportioned according to the classification following in the next column.

The Civic Center scheme, which conveniently groups all municipal buildings at one location near Market and Van Ness, is a feature of San Francisco's reconstruction that would not have been possible before the fire. A bond issue of $8,800,000 was authorized for this work on March 29, 1912, ground was broken on April 5, 1913, and at present the auditorium has been completed and the city hall is nearly finished. The city hall is to cost $4,000,000, and the structure itself is 300 x 400 ft. in plan. The Civic Center scheme was described in the Engineering Record of Oct. 31, 1914, and the chief features of the auditorium are outlined elsewhere in this issue.

San Francisco Building Permits, April, 1906, to January, 1915

Class	Number	Value of structures
A	177	$33,455,004
B	203	14,805,485
C	2,794	82,930,348
Frames	26,039	98,785,995
Alterations	25,144	19,034,096
Exposition	82	9,943,577
Public Buildings	12	4,397,163
		$263,351,669

High Pressure System

In safeguarding the city from a recurrence of the great fire of 1906 it has been the purpose to lay out a fire protection system that cannot be interrupted by earthquake. A high pressure system has therefore been installed which covers 7 sq. mi. of the more thickly settled district, and this is supplemented by 85 underground cisterns for emergency use, which are distributed over the city and have an average capacity of 75,000 gal. The cisterns are built of reinforced concrete, designed to withstand shock, and are free from fixed pipes for filling and emptying which might cause rupture. They are located at street intersections under a distinctive type of pavement, all locations being registered in each fire engine house.

Where the pipes of this high pressure system are laid on filled-in ground, double-spigot sleeve joints with steel sleeves have been used, and it is expected that this construction will stand considerable distortion without leakage. A complete description of this system appeared in the Engineering Record of July 26, 1913.

The high pressure system, 72 mi. long, was tested last June by connecting it successively with the Jones Street, Asbury Heights and Twin Peaks reservoirs, the resultant pressures in the business district being 150, 200 and 335 lb. per square inch respectively. With the 335-lb. pressure a 1¼-in. nozzle on top of a 314-ft. building on Market Street registered a pressure of 160 lb. per square inch.

LOWER MARKET STREET AND FERRY—ONLY A FEW GUTTED BUILDINGS REMAINED AFTER THE FIRE

Two pumping stations located near the waterfront have been provided, and are connected in the system so that they can supply salt water in case of interruption in the fresh water supply. The larger of the two, at Second and Townsend Streets, has four Curtis turbine-driven pumps, each of which has a capacity of 3000 gal. per minute at a pressure of 305 lb. per square inch. These are four-stage type, 12-in. in diameter, are rated at 750 hp and operate at 1800 r.p.m. They are supplied by eight 350-hp Babcock & Wilcox boilers which can be served with fresh water from six reservoirs beneath the building in case the usual supply is cut off. The pumping station in the Fort Mason reserve is similarly connected and has six 400-hp Stirling boilers supplying four convertible, condensing or non-condensing pumps.

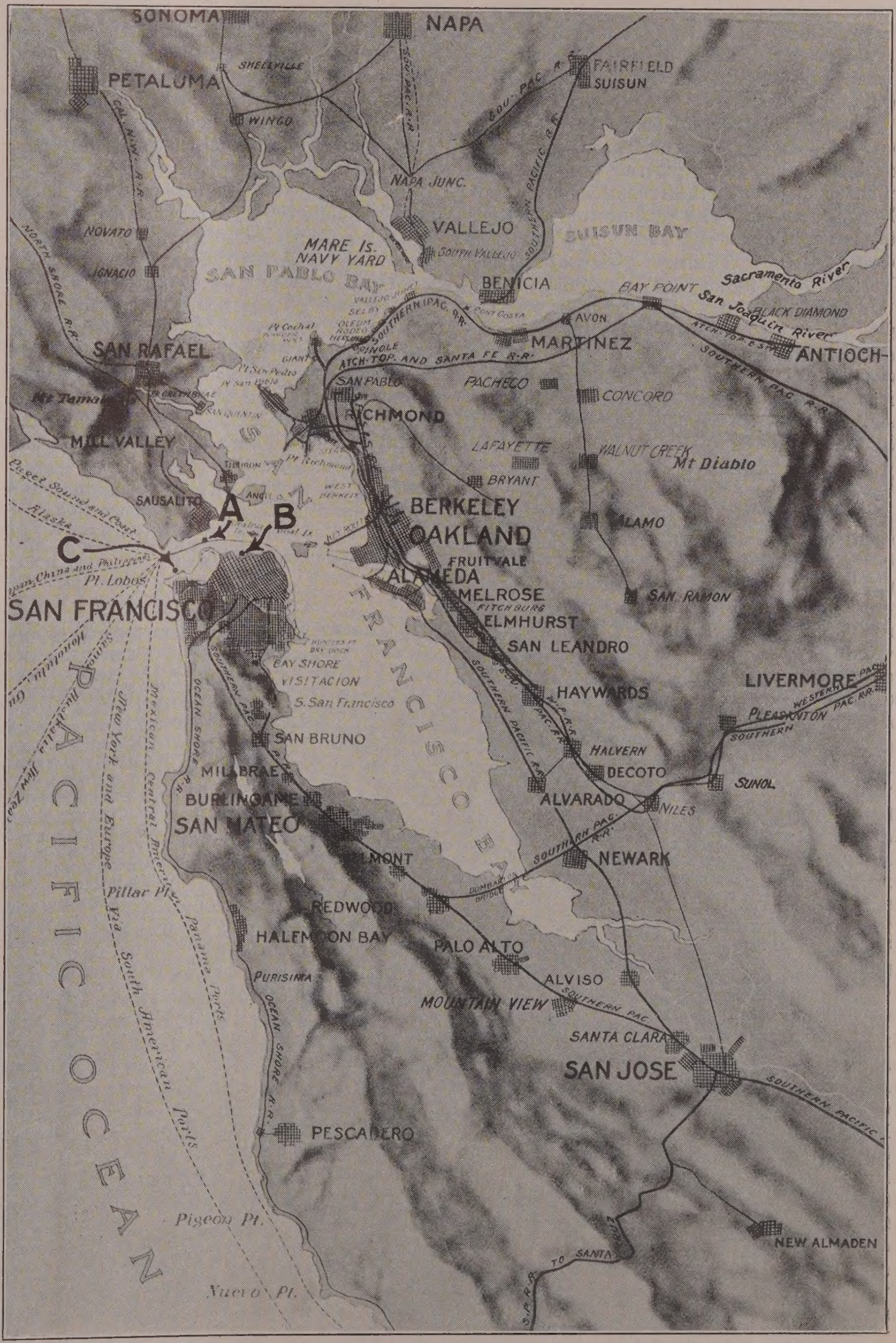
EMERGENCY STREET RAILWAY WORK

The quick rehabilitation of San Francisco's extensive railway system immediately after the fire is perhaps without parallel because of the extent of the work which had to be accomplished under the great difficulties faced in that period of stress. With power houses wrecked, streets blockaded and labor and material extremely hard to obtain, some of the lines were, nevertheless, ready for use before the authorities dared allow the current to be turned on. The Fillmore Street branch, for example, was in operation 56 hr. after the earthquake, and before the fire was entirely out. All the old electric lines were running within a month, and the entire Market Street trunk line was operated as an electric system over the old cable road rails six weeks after the catastrophe.

The United Railroads sustained a loss of several million dollars in the fire, which made it necessary to reconstruct the major portion of the system. Prior to the fire the single track electric mileage was 215.83 and the cable mileage 36.7. At the present time the electric line mileage is 265.69 and the cable mileage 14.7. Immediately after the fire 22 mi. of the old cable lines were rebuilt as broad-gage electric trackage, and of the 280 mi. of track on which the United Railroads now operate, 192 mi. has been reconstructed since 1902 and 160 mi. since 1906.

MUNICIPAL RAILWAYS

The municipal railway project in San Francisco is attracting widespread attention as the first venture of this sort in this country. In spite of the fact that its early failure has been frequently predicted it has thus far continued to extend its system steadily, has earned substantial net profits, and without a doubt it is continually growing in favor with the people of the city, whom it is serving more and more efficiently. The public sentiment favoring the municipal road has grown enough to be an important factor in questions of policy, and this must now be reckoned with by friend and



KEY MAP OF THE REGION IN THE VICINITY OF SAN FRANCISCO BAY

A, Golden Gate; B, Exposition Grounds; C, Mile Rock Tunnel foe alike, independently of the right of the controversy over its ultimate success.

After defeat at three prior elections, the proposition for authorizing $2,020,000 bonds for taking over the old Geary Street cable railroad for municipal operation was finally carried Dec. 30, 1909. On Dec. 28, 1912, ten modern electric cars were put in service on the new Geary Street roadbed between Kearny Street and the ocean beach, and on June 24, 1913, this line was extended down Market Street to the ferries. An election for authorizing $3,500,000 bonds for extending this single line into a complete municipal railway system was carried on Aug. 26, 1913, and since that date various branch lines have been added from time to time until now there are eight branches with a total length of 42.7 mi. of single track. The first car barn of the system, a reinforced-concrete structure at Geary Street and Presidio Avenue, has been enlarged to house 134 cars, and contract has recently been awarded for another reinforced-concrete barn at Seventeenth and Hampshire Streets which is to have a capacity of 100 cars.

When the exposition opens 197 cars will be in service on the municipal lines, most of these being the most recent type, built in accordance with the recommendations of Bion J. Arnold. The receipts on the lines of the municipal railroads have thus far been very encouraging to civic authorities. On a typical holiday in November, when some 40,000 people visited the exposition grounds, the total cash receipts on the municipal lines with 79 cars in operation was $4871.90. The average daily receipts in cash fares during the month of November, with 65 to 80 cars in service, were $3654.28.

MUNICIPAL TUNNELS

"At least one-third of San Francisco is practically unsettled as a result of the excess time required for reaching the outlying districts," said a noted engineer in reporting on the city's traffic condition early in 1913. This criticism is not likely to remain true if plans under way are carried to completion. The Twin Peaks tunnel, for example, will develop into home sites 7000 acres of land by bringing this area within 10 min. of Market Street instead of the 30 min. required by the present routes. This tunnel will be 12,000 ft. long and is practically a continuation of the outer end of Market Street. It has a cross-section of 25 x 18 ft., allowing just room for a double-track railroad, and has a maximum grade of 3 per cent.

A contract for this tunnel was awarded recently to R. C. Storrie & Company, and on Jan. 20 the approach cuts on the east and west ends had been advanced 100 and 200 ft. respectively, with a steam shovel at work in each. Extensive preliminary work in moving buildings, water and sewer mains and wires had been completed, and every preparation made for rushing the job through in the 1000 days specified in the contract. The construction costs plus land and rights of way are estimated to total $3,994,000, which is being borne entirely by assessment on property adjoining the portals. The assessment areas at the two ends are 4153 and 660 acres in extent respectively and the rates of assessment vary from 0.5 to 3.5 cents per square foot.

The tunnel is to be lined for its entire length with concrete in which 12 per cent of hydrated lime is to be used and a waterproofing finish coat of cement will be applied with the cement gun. At the present time it is proposed to place the lining by a pneumatic process similar to that in use on the Mile Rock sewer tunnel, described elsewhere in this issue. To facilitate ventilation, the cross-section of the tunnel has been divided by a horizontal concrete slab suspended from the arch at a height under which there is the required clearance. The slab forms a duct just beneath the arch, and fresh air that is forced into this duct by fans on the surface will be allowed to escape downward through openings into the tunnel.

The Stockton Street tunnel is also a municipal bore and has been in service only a few weeks. It is notable for its wide, flat arch, which has a rise of only 6 ft. in a clear span of 50 ft. It is 911 ft. long between portals and extends under Stockton Street from Sutter on the south to Sacramento on the north. Extremely heavy ground was encountered on this work, which was described in the Engineering Record of June 27 and Aug. 22, 1914, and in addition to the damages allowed prior to construction, the city has yet to adjust an impending law suit for damages to an office building over the tunnel that settled during the work.

The lining in this tunnel was also placed by the pneumatic process, but was first put through a mixer before being admitted to the air pipe. After the concrete was set a finish coat was put on by plasterers. Expansion joints were placed every 50 ft. in this tunnel, and consisted of folded copper plate 1/32 in. thick, filled with asphalt. The contract price was $337,000, but as the arch was thickened after the original design, the structure has cost $415,000 and the lands and damages $200,000. Construction and damage costs were met by assessment on property owners benefited, the location and area of assessment districts as well as the rate of levy being determined by the city engineer's office.

SEWERAGE SYSTEM

Both combined and separate sewerage systems are in use in San Francisco, the former, however, carrying the major portion of the sewage. When the present sewerage project is completed there will be six outfalls discharging into the waters of the bay or the Golden Gate, with provision for relief discharges to be used automatically in times of heavy storms. In order to discharge the sewage into strong tidal currents where possible, the outfalls have been led to the north end of the San Francisco peninsula, and the important outlets are between North Point on the east and the Cliff House on the west.

Work was commenced on the present sewerage system in 1904, and although delayed for a time by the catastrophe of 1906, this event in reality made it possible to carry out the ultimate scheme much more expeditiously. Previous to 1906 there were over 125 sewer outlets along the bay shore, but as the district tributary to these was rebuilt, sewer connections were made to the trunk sewers newly constructed in accordance with the general scheme. The largest of the new combined sewer mains, which is to have a total length of 6 mi., discharges at North Point near the foot of Sansome Street. This sewer serves an area of 11,050 acres in which 75 per cent of the population of the city reside, and, in addition, will handle the sewage from three of the separate systems which is to be pumped into it.

The design of the storm sewers was based on a continuous rainfall for one hour of 0.598 in. with a maximum fall in 5 minutes at the rate of 2.16 in. per hour. With a population of 20 per acre the run-off assumed was 30 per cent, and this was increased uniformly up to 75 per cent for 100 residents per acre. For the domestic sewage flow it was assumed that the average water consumption was 70 gal. per capita per 24 hr.; and a maximum flow for short periods was assumed as 50 per cent in excess of this average. The rate for domestic sewage flow was taken as 0.163 sec.-ft. per 100 inhabitants. The allowance made for ground water infiltration was usually 0.002 sec.-ft. per acre, according to conditions. The system is designed in accordance with the assumption that in 50 yr. the maximum sewage flow from the city will be 215 sec.-ft. The minimum average outflow through the Golden Gate in any 7-hr. period, reckoning both tidal flow and river discharge, is taken to be 3,970,000 sec.-ft.

GARBAGE DISPOSAL

At present, part of the garbage of San Francisco is consumed at a reduction works in the southern section of the city and part is towed out through the Golden Gate on barges and dumped into the ocean. The need of a greater capacity than that of the old reduction works, long ago outgrown, was recognized in due time and the contract for a modern plant was awarded in November 1910. This plant was to be supplemented by duplicate units in other parts of the city after the features of its design had been shown to be adapted to the local needs.

After facing many difficulties in the long construction period, the contractors pronounced this first unit, the Islais Creek plant, ready for test late in August, 1914. The test was accordingly made by the city engineer, and on his recommendation the Board of Public Works rejected the plant and ordered the contractor to refund the payment already made and remove the incinerator at his own expense. Since that time no new plan for the disposal of garbage has been presented for consideration.

REPORT OF CITY'S TEST

Because of the interest which centers in the reasons for rejecting the garbage disposal plant, the following data, taken from the official report of the city engineer's test are presented:

The tests extended over the period between Sept. 4 and Oct. 3, and were carried out in accordance with the terms of the contract which placed the responsibility for the design upon the contractor and required him to provide a plant that would accomplish certain specified results. During nine days of the test run samples of the garbage handled were analyzed by the city chemist and found to contain an average of 52.4 per cent of moisture and 25.8 per cent of combustible matter. The maximum variation between the moisture contents of samples taken on different days was 8.9 per cent, while the combustible matter content varied not more than 4.6 per cent.

A grayish smoke issued from the chimney of the incinerator at all times during operation, the city engineer reported, and the fumes were the cause of complaints from residents of the vicinity. Obnoxious gases also escaped through the skylights of the main incinerating building, which it was necessary to keep open in order that the temperature of the stoking floors should not reach an abnormal height. On one day this temperature was 130 deg. Fahr. The windows in the clinker crushing building also had to be left open in order to permit the escape of dust that otherwise made it difficult for workmen to remain in the building.

During the test run temperatures in the combustion chambers occasionally fell below the specified minimum of 1250 deg. Fahr., but the average was well above the 1500 deg. Fahr. required. More or less unburned material was usually found in the residue, the maximum being about one-half a cubic foot per cubic yard of residue. Delays due to breakage and repair of equipment during the 30 days amounted to 117 hours and 35 minutes, sixteen minor accidents being recorded during the test.

These features in which the plant failed to fulfil the specifications were the basis for the city engineer's recommendation that the incinerating plant be not accepted and that the contractor be required to refund to the city the $108,000 which had already been paid on the total contract price of $255,256.

During the 30-day test the plant was operated by the contractor and the cost of operation was computed by the city with the results shown in the accompanying table.

COST OF OPERATION FOR 2,804.62 TONS

Labor and miscellaneous costs of incineration and handling clinker	$2,860.80
Salary of superintendent	175.00
Salary of two clerks at $80 each	160.00
Fuel oil and maintenance	416.66
Water	140.00
	$3,752.46

This gives an average of $1.3379 per ton, from which should be deducted $0.60 per ton charged the scavengers for receiving refuse, leaving $0.7379 as the net operating cost per ton. The Islais Creek garbage incinerator was described in the Engineering Record of Aug. 16, 1913.

San Francisco's Notable Engineering Works

A Summary of the More Interesting Projects Near the City with Special Attention to Construction Now Under Way—A Useful Guide for Engineers Who Attend the Exposition

A VAST amount of engineering work is now in progress on the Pacific Coast, in spite of the period of depression through which the country has been passing. Because there is so much construction to be seen in the vicinity of that city toward which the attention of the entire country is now being directed, a review of the more important projects under way there is presented in this issue. The primary purpose is to give a brief general survey of work in various branches of the profession with reference to previous articles on the important subjects, and with detailed information on some work that has not been described heretofore.

For the benefit of engineers who visit the exposition, the Engineering Record has provided a booth in the Palace of Machinery where its local representatives will be prepared to supply desired information.

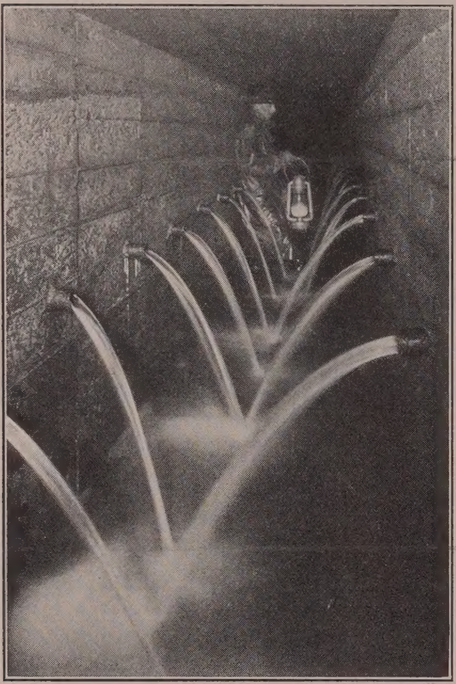
HARBOR IMPROVEMENTS

A feature of the harbor work at San Francisco that is worthy of special attention is the great variety in the types of pier construction. Although good results have always attended the use of creosoted piles, construction has by no means been confined to treated timber. Wooden piles encased in concrete both with and without reinforcement have been tried as well as concrete piles cast in place in wooden cylinders that are first driven to hard foundation and then pumped dry. A great deal of concrete pile construction is under way and piles up to 91 ft. long have been designed. A favorite type of pier is that built on reinforced concrete cylinders supported on large concrete bases which in turn rest either on a solid bottom or on piles if the bottom is soft.

Pier construction has been progressing very rapidly in San Francisco in the past few years in anticipation of a stimulated trade following the opening of the canal. At the present time five new piers and four ferry slips are under construction and others have just been completed. The new piers on the north water front between Lombard and Taylor Streets are 150 to 200 ft. wide and 800 to 1000 ft. long with one and two story sheds. Perhaps the most interesting of these now under construction is pier 35 at the foot of Kearny Street. It has concrete cylinders supported on piles driven well below the dredge line inside the caisson, their heads being imbedded in the concrete bases. The deck is of concrete surmounted by a steel frame shed, and the length is 975 ft. South of the ferry building are four recently completed concrete piers, 26, 28, 30 and 32, which were mentioned in a general description of the harbor improvements that appeared in the Engineering Record of July 12, 1913. All new piers south of the ferry building are finished in old mission style, while piers on the north are given a Chelsea architectural treatment. The tidal fluctuation in the harbor averages 4.5 ft. with a maximum of 7 ft.

The port of San Francisco has always been self-supporting, and between 1863 and 1910 much of the $14,230,000 spent in improving the harbor came from its own revenues. In 1907, however, there was ap-

CRYSTAL SPRINGS DAM NEAR SAN MATEO WHICH STORES 24,000,000 GALLONS FOR THE SPRING VALLEY WATER WORKS SYSTEM proved for harbor improvement a $2,000,000 bond issue which was followed by another in 1909 for $9,000,000. In 1910 an expenditure of $1,000,000 was approved for the purchase of tide lands to be held until needed for future extensions, and at the recent election in November $10,000,000 bonds were authorized for pier construction and general port improvements. It might also be noted that in the rivers and harbors bill passed by Congress in December there was included $230,000 for Sacramento and Feather River improvements and $150,000 for Oakland harbor work.



INFILTRATION GALLERY AT SUNOL

Most of the new piers at San Francisco are provided with both surface and depressed railroad tracks, and connections between docks, ferry slips and trunk railroads are attained through a belt line railroad operated by the board of harbor commissioners. This line has a total trackage of about 3.7 mi. and extends northward along the water front from a southern terminal in Channel Street, through Fort Mason tunnel and into the exposition grounds. Seven locomotives owned by the State are operated on the belt line.

SPRING VALLEY WATERWORKS

The Calaveras dam, situated about 40 mi. southeast of San Francisco, is one of the most interesting projects that can be seen under construction in the vicinity this season. In addition to being the highest structure of its type yet attempted, the concrete intake tower and tunnel are also of exceptional interest, representing as they do the product of the best available talent working on engineering problems of an unusual nature. Furthermore, the site is near the earthquake fault line of 1868.

The dam, which is to be 220 ft. high and has now been built to a height of about 60 ft., is of the hydraulic fill type similar to the San Fernando dam described in the Engineering Record of July 11, 1914. It is 1320 ft. from toe to toe on the bottom, 1300 ft. long on the crest and will contain over 3,000,000 cu. yd. of material which is being pumped from favorably located pits. Beneath the dam is a culvert 19.5 x 19.5 ft. in section, calculated for a flow of 12,000 sec.-ft. and provided with exterior concrete collars 5 ft. thick to prevent seepage.

The concrete intake tower, also 220 ft. high, is heavily reinforced, being designed to resist slight earthquake shocks, an acceleration of 6 ft. per second being taken into account. It has an outside diameter of 28 ft. at the base where the walls are 4 ft. thick, and 13 ft. at the top where the walls have been reduced to 18 in. in thickness. Its foundation is an octagonal concrete block 9 ft. in depth, into which alternate reinforcing rods from the tower are embedded 5 ft. deep.

The Crystal Springs concrete dam, another part of the Spring Valley water supply system, is situated 4 mi. from San Mateo. It was built in 1887 by laying the concrete in blocks 20 ft. long, 12 ft. high and 12 ft. wide, the forms leaving keyways in each. The method was to build alternate blocks and after removing the forms to fill in the intervening space with concrete. This dam impounds 24,000,000,000 gal.

FILTRATION PLANT AT SUNOL

At Sunol, 35 mi. from San Francisco, a gravel bed 1300 acres in extent and varying in depth from 20 to 40 ft. is used as a filtration plant. Beneath the gravel there is an impervious substratum of clay in the lowest portion of which a concrete infiltration gallery collects the waters from several rivers after they have percolated through the gravel bed. The system of concrete galleries is over a mile long, the main chamber being 20 ft. high and 5 ft. wide. Water flows into these galleries through 2-in. pipes which pierce the gallery walls every 4 ft. on either side, and the galleries, in turn, discharge into the mains that supply San Francisco.

This supply passes under the bay through two 16-in. and two 22-in. mains laid in 1888 near the Southern Pacific Railroad crossing. The mains are lap-welded tubing that was first galvanized inside and out and then treated with asphaltum inside and out. The lines are each 6600 ft. long and have flexible joints which permit of an angular movement of 21.5 deg.

In the city proper, water supply system is arranged in five separate pressure districts, according to topography, and nine distributing reservoirs on as many heights supply some 60,000 ft. of wrought iron pipe 22 to 44 in. in diameter, and 2,000,000 ft. of cast iron pipe 3 to 30 in. in diameter.

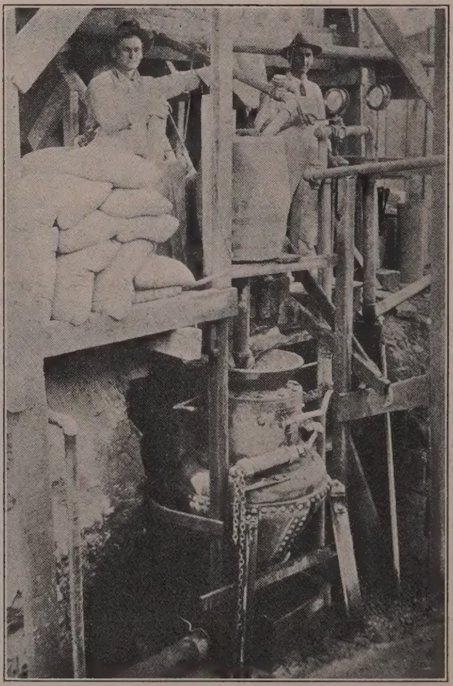
At the present time the purchase of the Spring Valley system by the city is under consideration, and an election on the question will be held in March. A condemnation suit instituted by the city has been pending for some time because an agreement on the price could not be reached, but it is now possible that an adjustment may be made outside the courts. The price to be paid by the city will probably be between $34,500,000 and $37,000,000.

HETCH HETCHY PROJECT

With the exception of Denver, San Francisco is the only large city in the United States that does not own its water supply system. For over 10 years a bitterly contested campaign has been carried on to secure rights to a source of mountain supply for San Francisco, and only on Dec. 19, 1914, was the President's signature obtained on the Raker bill. By the terms of this act the city was granted permanent rights of way and is insured the perpetual use of a watershed from 3000 ft. to 10,000 ft. in elevation on the westerly granite slopes of the Sierra Nevada Mountains, which is 420,000 acres in extent and is capable of being developed to supply 400,000,000 gal. of water daily.

The first step in the Hetch Hetchy development is the construction of suitable roads over which materials can be transported to construct the dam and aqueduct. A fairly good road over the 20 mi. stretch between Smith's Station and Hog Ranch was already in existence, and the first contract on the Hetch Hetchy project was recently completed when the 9¼-mi. road from Hog Ranch to the dam site was finished. This new road is 22 ft. in width, has a maximum grade of 4 per cent and will probably be used temporarily for the construction railroad. A total of 66 mi. of railroad will have to be built between the nearest rail connection at Oakdale and the dam site. This construction is made necessary by the 350,000 tons of material which will have to be hauled in during the work.

The Hetch Hetchy dam which is now being designed will be built to a height of 300 ft. and will impound 112,000,000,000 gal. of water. On the completion of the dam this volume of water at an altitude of 3600 ft. will be immediately available for the generation of hydro-electric power which may be used by the city and sold to irrigation districts. It is expected that the income from this source will partially compensate for the cost of mountain development. For the present, on the completion of the dam, the water will be permitted to flow down the natural stream bed of the Tuolumne River to the first point of diversion at the Early Intake.



CONCRETE PLANT AT MILE ROCK TUNNEL

While work is in progress on the Hetch Hetchy dam and on 20 mi. of aqueduct west from the Early Intake at an altitude of 2320 ft., construction will also be started on a forebay reservoir of 2000 acre-feet capacity at an elevation of 2170 ft. and on a permanent power plant with a capacity of 60,000 hp to be located at Moccasin Creek. As a first installation a 30,000-hp unit will

CONSTRUCTING HYDRAULIC FILL LEVEE ON LOWER SACRAMENTO RIVER

be put in use, to be doubled as the demand requires.

The power house site is located beside the main highway at Moccasin Creek, 141 mi. from the city hall in San Francisco. At this station there will be a net drop of 1250 ft. The total ultimate power capacity on the entire project will be about 200,000 hp.

BRINGING THE WATER IN

From Moccasin Creek power house water will flow from an altitude of 870 ft. in a concrete-lined tunnel 12 ft. in diameter a distance of 16 mi. to the easterly edge of the San Joaquin Valley at an elevation of 785 ft. The 45 mi. level stretch across this valley will be crossed by an inverted syphon-pipe conduit under a maximum head of 200 lb. per square inch. One pipe will be laid for the first installation and a second one parallel to it later. The San Joaquin River will be crossed by a submerged syphon about 600 ft. long. At the westerly edge of the San Joaquin the water will be diverted into a concrete-lined pressure tunnel commencing at elevation 374 ft., 32 mi. in length to the proposed Irvington gatehouse, altitude 280 ft.; thence it will be taken by pipe for a distance of 19 mi. crossing San Francisco Bay at Dumbarton Narrows or around the head of the bay to a point of suitable elevation in San Mateo County, whence it will flow by gravity either into the Crystal Springs Reservoir, if the Spring Valley Water System is acquired, or directly to a main aqueduct line leading into the city.

Due to the unsettled financial condition, which is the result of the present European conflict, there is no present demand for the 4½-per cent bonds from which funds for the construction of this project must be immediately obtained. As soon as this market condition is improved the work will undoubtedly progress as rapidly as possible, and on its completion it is expected that the supply available will be adequate for a century to come.

MILE ROCK SEWER TUNNEL

Mile Rock tunnel is being driven in a north and south direction under the hill just back of the Cliff House to convey the ocean interceptor sewer to an outfall in the swift tidal currents of the Golden Gate near Mile Rock. The tunnel is 9 x 11 ft. in section and about 4200 ft. long. At the present time work is well under way, about 1300 ft. of the lining has been completed and the headings are expected to meet in about three months.

A notable feature of this work is the placing of the concrete lining which is usually kept up to within about 50 ft. of the heading and which is not interfered with by blasting and mucking and which, in turn, does not hinder any of the driving processes. At the present time ¼-cu. yd. batches of concrete are being transmitted 1300 ft. in a 6-in. pipe, and it is expected that this distance will be increased as the work advances. If feasible, concrete will be transmitted by this method through adits near each portal as much as 1800 or 1900 ft. to the center of the tunnel.

No concrete mixer is used with the apparatus on this work, and for the entire operation of mixing and placing only four men are required, two to charge and operate the pneumatic plant and two at the forms to place the charges and signal the operators outside. When thus placing concrete in forms 900 ft. from the charging plant, it was customary to average a ¼-cu. yd. batch per minute with a compressor capacity of 560 cu. ft. of free air per minute. At this time the rate of progress was a 32-linear-foot section of tunnel in 5 to 6 hr., which was usually the equivalent of 40 to 60 cu. yd. of concrete, according to overbreak.

FLOOD CONTROL PROBLEMS

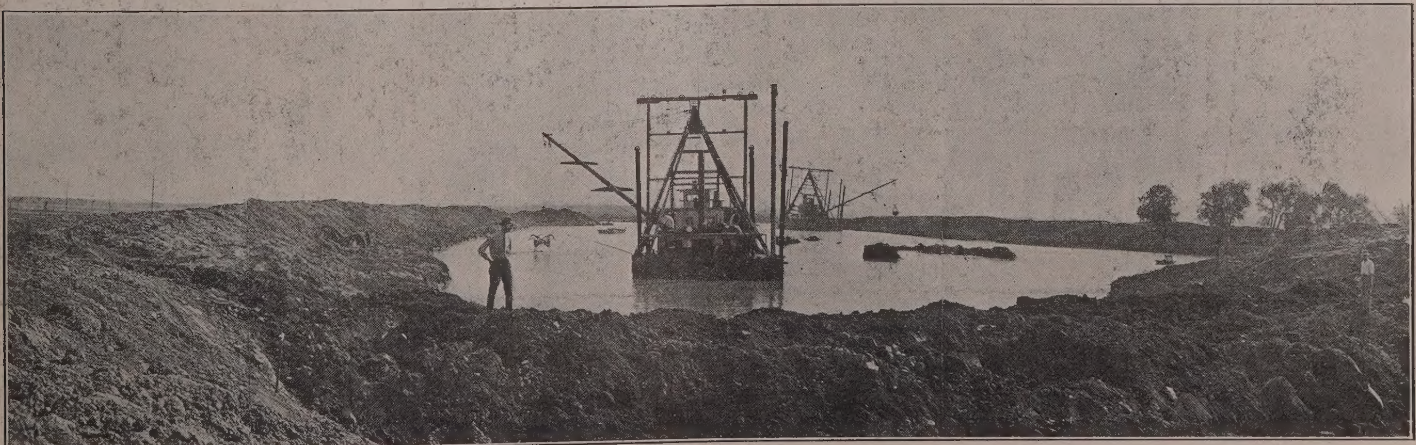
The Sacramento River for some 150 mi. of its course has a channel capacity entirely inadequate to carry even ordinary high waters. Between Colusa and the mouth of the Feather River, for example, it can be made to carry between high levees about 65,000 sec.-ft., while in the season of 1907 there was presented at this part of the valley a flow of 250,000 to 300,000 sec.-ft., most of which, of course, flowed across country outside the normal channel.

It has been found impracticable to build levees high enough to retain the flood waters, but as the river banks are naturally high, sometimes 15 to 20 ft. above the land for a mile on either side, it is necessary to control the waters in some way in order to protect property. The policy adopted has been to allow the excess capacity flow to escape at points where it can be controlled at a lower level, and by means of dikes, to confine this overflow within certain bounds until it has passed down the valley to a point where re-entry into the normal channel or into Suisun Bay is feasible.

Projects of this sort under way include the increase of channel capacity by eliminating bends and widening and deepening portions of the river. According to plans of the U. S. Army Engineers the main channel of the Sacramento River is to be flanked by a series of weirs and all flows in excess of a stipulated amount at each of these points will be passed out over the weirs, thus regulating the flow in each section of the main channel to predetermined amounts.

HYDRAULIC FILL DIKES

Levee work on the Sacramento River has of late been carried out extensively by the hydraulic fill processes and since levees of this type are almost entirely of sand they have the great advantage of being proof against burrowing animals. For some 25



GRAB-BUCKET DREDGES WITH 180-FOOT BOOMS EXCAVATING BY-PASS AT KNIGHTS LANDING mi. between the mouth of the Feather River and the city of Sacramento, the east bank of the river has been built up by dikes of heights ranging up to 20 ft., and both the hydraulic and the grab bucket processes can now be seen in progress there. The cost ranges from 6 to 10 cents per cubic yard, being about the same for either method. Booms up to 240 ft. in length with 6 cu. yd. buckets are being employed on the bucket dredges.

Some of the most interesting dikes are being built on the Natomas Consolidated, known as reclamation district 1000, or the hydraulic process may be seen to advantage just across the river from the city of Sacramento in reclamation district 900 where a heavy fill is being made by this method without the use of retaining walls of any sort. In this work pure sand is handled and the slopes are 1 to 3 on the river side and 1 to 20 on the land side.

The accompanying view of grab bucket dredges shows work under way on the Knights Landing cut where a by-pass channel is being made to duplicate the river capacity. The dredges shown have 180-ft. booms and 5-cu.yd. buckets. The new channel is 420 ft. wide with water 8 ft. deep; the top of the embankments are 32 ft. above water level and their base width is 240 ft. Beams 20 ft. wide are used and the slopes are 1 to 3 on the levee and 1 to 1 in the cut. The view of the hydraulic dredge line shows a 20-in. pipe on reclamation district 900 discharging sand through 4 x 8-in. sliding door openings in its lower side. This method allows most of the water to go to the end of the open pipe line while nearly all the sand is deposited without excessive water. The pipe is placed along the axis of the levee, 2 ft. above grade.

Electric Power

Five out of eight San Francisco substations in the Pacific Gas & Electric system were destroyed in the fire of 1906, and at the present time eleven substations are in use within the city proper. The one of these that involves features of greatest interest is steam generating station A, which contains two 15,000-kva and one 12,000-kva Curtis steam turbines. The power system of this company is supplied, in addition to steam auxiliaries, by six hydro-electric generating stations in the Sierra Nevada mountains whence high tension transmission lines bring the current to the bay cities. Of special interest to structural engineers is the 100,000-volt tower line between San Rafael and Vallejo, finished about a year ago, and on which are 16 steel towers ranging from 160 to 250 ft. in height.

Power for the United Railroads and the Municipal Railway system is supplied by a subsidiary of the former, known as the Sierra & San Francisco Power Company. An active competitor of the Pacific Gas & Electric Company is the Great Western Power Company whose chief source of power is the well known Big Bend plant on the Feather River.

New Departures in Gas Service

Typical of recent developments in San Francisco in the illuminating gas industry is the gas system supplied to the exposition. Pressures up to 100 lb. per square inch are being used in delivery mains, and the minimum pressure at the exposition grounds is 40 lb. per square inch. The main gas artery to the grounds is a 16-in. steel pipe from which an 8-in. continuous loop encircles the grounds and has in turn 2 and 4-in. branch loops. At each of the palaces a district governor reduces the high pressure to a working range of 4 to 6 in. and distributes to the light and heat systems.

The mains of the installation are welded by the oxy-acetylene process—a new departure recently introduced in this work by this company—which gives a continuous system without danger of leakage at the same time that the cost of connections is reduced to one-fifth that required by the old method. Other advances pointed out in the San Francisco system to mark recent progress are the application of mechanical boosting for raising street main pressures and improvements in the manufacturing process which eliminate lamp black and increase the efficiency of oil gas.

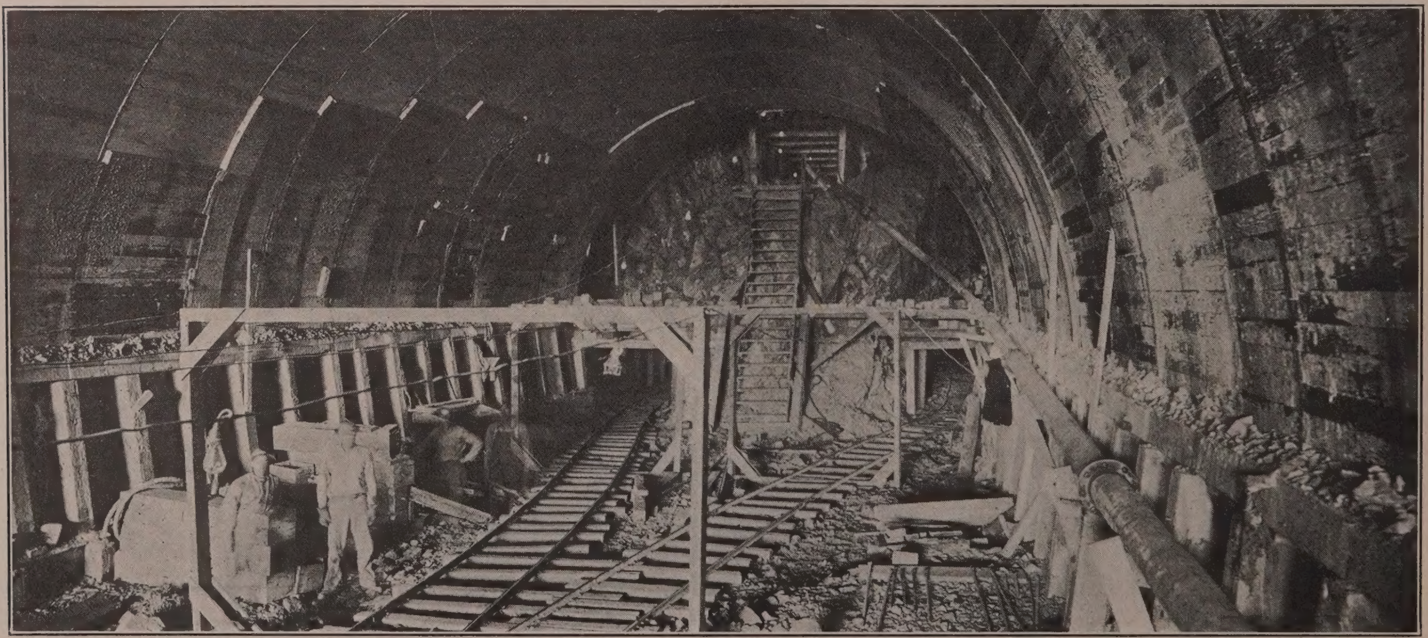
Richmond Tunnel

The municipality of Richmond, located on the east side of San Francisco bay, has under way an extensive harbor development scheme, and in order to provide ready access to the proposed docks a tunnel is being driven through the range of low hills that separate the city from the bay. The tunnel work has been carried out in a way calculated to reduce the construction period as much as possible, and most interesting data on the life of steel pipe used in the pneumatic concrete placing method has been compiled. All the work of excavating approaches and driving and lining the tunnel was first classified in detail and the cost calculated on a unit estimate basis. Although a new departure in the contracting field, this method is said to have given remarkably accurate results.

The tunnel is 732 ft. long between portals, 35 ft. wide at the springing line, and the lining required 5617 cu. yd. of concrete. The material excavated between portals will total 24,500 cu. yd., and 82,500 cu. yd. were taken from the two approach cuts, of which 75 per cent was rock. The tunnel was driven on the three-drift system, with one 8 x 8-ft. drift on each wall line and another at the crown with its top 18 in. above the level of concrete finish. The tunnel is to have a descending grade of 2.557 per cent from the south to the north portal, and as all material removed had to be deposited in fills near the north end, the drifts were all started at the north and driven up grade to the south portal so as to gain the advantage of gravity in handling the muck.

After driving the headings entirely through to the south portal the enlargement of wings and section was begun; and all material excavated was trapped into cars in the two wall drifts, these cars being handled by a 5-ton electric locomotive. The excavation was followed back from the south end by eleven-segment timber lining on 9.5-ft. posts with back-lagging to constitute forms for concrete lining. All overbreak was grouted with a mixture of one part of cement to sixteen parts sand, figuring just enough cement to make the mix set, as when the timbers were removed for each alternate section of concrete the back-lagging remained in place.

The electric locomotive was equipped with a pantograph collector instead of the ordinary trolley, and this is said to have added greatly to the efficiency of the machine in switching and in changing from forward to



CONSTRUCTION OF THE RICHMOND TUNNEL—SEGMENTS, DRIFT ARRANGEMENT AND CONCRETE PIPE

EXTERIOR CONSTRUCTION PLANT AND EQUIPMENT AT THE NORTH PORTAL OF THE RICHMOND TUNNEL

reverse, besides insuring good contact on the temporary lines.

In grading a roadway to the south approach cut, 228,000 cu. yd. of material was removed in 210 working days of 8 hr. with a 65-ton Bucyrus shovel using a $2\frac{1}{2}$-cu. yd. bucket, the ground having been previously drilled with a 6-in. Keystone drill. Two men did all of the drilling in 90 days and the holes were so placed that with one exception the shovel was never interrupted by material unbroken by the blasts. The material was hard blue trap rock and shale. Drill holes were spaced on 20-ft. centers, sprung and loaded with 7 to 12 kegs of black powder, and 6 to 8 holes were simultaneously fired by battery.

PLACING CONCRETE PNEUMATICALLY

All concrete lining, with the exception of about 60 ft. at the north portal, was placed by the pneumatic method, and at the height of the work 22 linear feet of lining, or 184 cu. yd. of concrete, was placed in $5\frac{1}{2}$ hr. This rate could have been increased considerably, it is believed, if greater compressor capacity had been available. In fact, on this work it developed that with an 8-in. delivery pipe, 1.3 cu. ft. of free air per minute was the desirable amount for each foot of delivery pipe line when working at a 120-lb. pressure. The pneumatic method was used for placing the sand mix as well as the concrete, and for this purpose the end of the 8-in. delivery pipe was inserted in holes made every 20 ft. in the center of the timbered arch. This sand mix was placed at the same pressure as the concrete, and at every point where inspection was made all voids were filled perfectly.

The wear on the delivery pipe was found to be a very important factor in the concreting work and special effort was made to analyze and improve conditions that effected this. It was found that the velocity of a 16-cu. ft. charge of concrete averaged from 75 to 100 ft. per second, under a 120-lb. pressure, and that bends of 4-ft. radius in the 8-in. steel pipe would not wear longer than for an average of 60 hr. of continuous pouring. Bends of longer radius were not only costly, but evinced a tendency to clog because the concrete would cling to the outer curve, allowing the air to pass by along the inner side.

It was found undesirable to use curves of more than 4-ft. radius, and cast manganese steel was found to be the most economical material in the bends. One 4-ft. radius bend of 8-in. extra strong steel pipe $\frac{1}{2}$ in. thick was cut through in 12 hr., and the rapid wear was attributed to the reduction of thickness in the outer curve due to bending the piece. A peculiar characteristic noted was that on a straight line with ascending grade of 7 per cent the delivery pipe wore on top considerably more than on the bottom and invariably cut through the top first. The life of the ordinary 8-in. steel pipe used on straight sections of the line was found to be sufficient for handling 6000 cu. yd. of concrete. However, most of the pipe used was not quite new when bought for the job.

Pipe with the standard threaded or flanged connections was found very unsatisfactory because of the amount of time lost making connections, or because threads reduced the thickness of metal at points where wear seemed to be most noticeable. The pipe recommended, after experiment, was to have a welded flange with a patent lock connection in which one bolt in a hinged clamp is used instead of the usual eight bolts at each joint.

Excavation was commenced April 1, 1914, and completed, with exception of core, on Dec. 3. The lining was finished on Jan. 20, half the core had been removed by the end of the month and the date of final completion is now estimated as March 15. The Shattuck-Edinger Company holds the contract, and the construction scheme has been devised and supervised by E. J. Carillo.

EXPOSITION ENGINEERING

In the last decade such rapid progress has been made in the many branches of engineering that the construction of an exposition at the present time is, pre-eminently, an engineering project. The design and construction of the Panama-Pacific Exposition has involved important engineering problems in almost every branch of the profession, and although the main features have all been described in detail in the Engineering Record, it is worth while to review some of the more important work on which the large engineering force has been actively engaged for the past two years. In addition to the many questions of structural design a complete complement of public utility service had to be provided, each with its problems peculiar to exposition uses of electricity, gas, steam, water, compressed air, sewage and telephone systems.

The preparation of the site involved a hydraulic fill of 1,700,000 cu. yd. which cost $301,000 and which was carefully placed in the proportion of 70 per cent sand and 30 per cent silt so as to reduce settlement and make the resultant fill available for immediate service. The finished site represented a cost to the Exposition Company of $1,000,000. City planning problems were involved in the grouping of the various palaces, lakes and roadways; climatic conditions were considered and the layout finally approved is thought to require the absolute minimum of travel between buildings consistent with the architectural effect desired.

BUILDINGS DESIGNED WITH VIEW TO SALVAGE

Nearly all the buildings are on pile foundations with floors supported independently of the frame. Pile tests showed that the new fill, in settling, gripped the piles so as to force them downward, and it was seen that if loads were applied on short piles they would settle even more rapidly than the fill. A successful solution was reached by arranging to drive all piles to a certain strata whose depth at various points was determined, and no pile was left until the penetration under the last blow was less than a specified maximum.

In the design of all structures the question of salvage value was considered, and while no risks were taken in providing adequate strength, the buildings were made so as to be wrecked easily. Steel was used only where required for strength, the three steel structures being the tower of jewels, fine arts building and part of the Palace of Horticulture. Concrete was restricted, for the most part, to those structures where fire proofing was required. The building design was perhaps the largest problem which confronted the engineers, and in order to meet every requirement of soundness and strength within the cost that could be allowed for temporary structures, some unique solutions were worked out. Machinery Hall, which is the largest timber building ever erected, is one of the examples of this.

The same limitations as to cost and temporary construction applied, of course, to other work besides the structures themselves and introduced in each branch its own peculiar problems. Some 4,700,000 sq. ft. of pavement had to be laid, and as 15 per cent of this was on filled ground many of the main roadways were provided with reinforced concrete base to insure freedom from settlement. Provision was made for a fresh water supply of an average of 2,750,000 gal. per day at a pressure of 80 lb. per square inch and with a maximum rate of flow of 150 per cent of the probable maximum draft.

Both combined and separate sewer systems are in use on different parts of the grounds, and a 100 per cent run off had to be allowed for 63 acres of roof area of the main palaces. Sewage has to be pumped from some of the lower portions of the grounds, and because of possible settlement in the earth fill, flexible pipe was used in some parts of the system to obviate the possibility of leakage. For 8 to 15-in. sewers vitrified pipe was used, and for 18 to 30-in. mains wood-stave pipe was specified.

The main fire protection system is capable of delivering 15,000 gal. per minute over an area of 100,000 sq. ft. There will be a normal pressure in the mains of 200 lb. per square inch, and connections are provided by which fire boats can pump salt water into the system. Flush hydrants spaced about 300 ft. apart are directly over the mains which range from 6 to 16 in. in diameter. Fire companies will be stationed at various parts of the grounds with the latest type of motor-driven apparatus, and will be served by an elaborate alarm system with independent underground circuits.

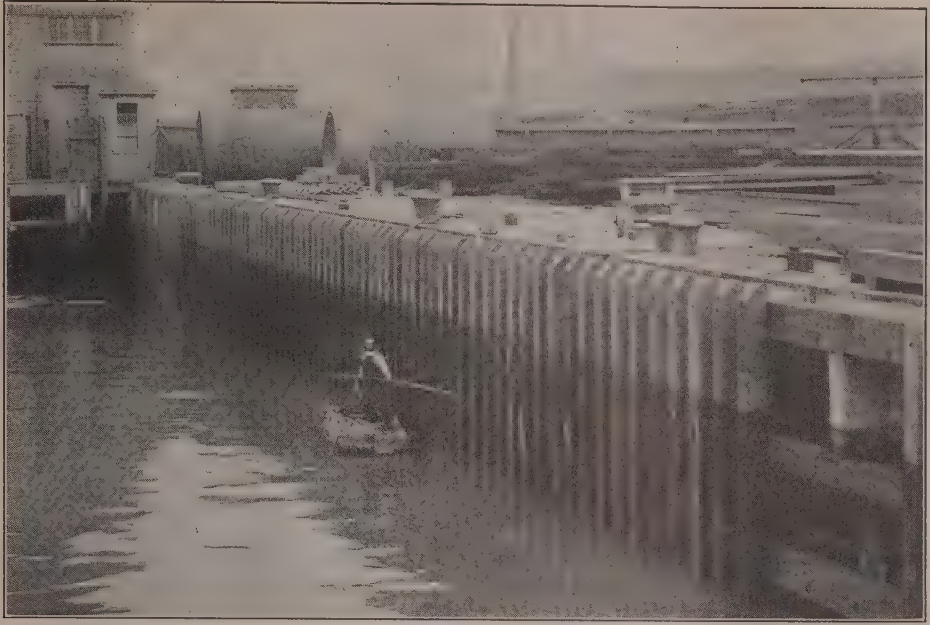
After the close of the Exposition all the buildings will be wrecked and the grounds are to be restored and turned over to original owners with the exception of about 12 acres which has been purchased outright by the exposition company. The total budget for site, fill and all construction undertaken by the exposition company was about $14,500,000, and it is a notable fact that the cost of the work has been kept within the limitations of the budget.

Colorado Highway Improvement Work in 1913 and 1914

COLORADO Highway Improvement Work for the years 1913-14 included 2640 mi. of road grading at an average cost of $430 per mile. In connection with bringing the roads to a moderate grade a great deal of rock work and heavy cuts were encountered in the mountain sections. Crowning and ditching are included in the average cost. The ruling grade is 6 per cent. About 196 mi. of State road were surfaced with gravel or sand-clay, but mostly gravel, at an average cost of $500 per mile, not including the grading, bridges or culverts. There have been built 221 bridges, of all sizes from 6 to 540 ft. in length, at an average cost of $1000 per bridge. Culverts to the number of 1498 and ranging in size from an 8-in. pipe to a 6-ft. culvert have been placed at an average cost of $50 per culvert. The work was carried out under the supervision of the Colorado State Highway Commission, of which J. E. Maloney, an engineer, is secretary.

CHICAGO'S REVAMPED MUNICIPAL GARBAGE PLANT made a net profit to the city of $5,764.49 for the eleven months it operated in 1914, according to the Health Department. For nearly five months of this time, during the rehabilitation period, there was a considerable labor charge before any income could be derived. The two largest items of the $129,708.09 outgo are $75,678.49 for labor and $30,052.96 for fuel oil. Receipts were $113,701.55. Dr. G. B. Young, health commissioner, credits against the apparent loss the proportionate amount the city formerly paid a contractor for the service—$47,500 per year—and then deducts an interest charge on the $683,000 investment of $21,770.63 to give the profit mentioned.

ILLUMINATION BY NIGHT OF THE TOWER OF JEWELS—PANAMA-PACIFIC INTERNATIONAL EXPOSITION



FENDERS SUSPENDED TO KEEP THEM OUT OF REACH OF MARINE BORERS

Suspended Fenders a Feature of New Reinforced-Concrete Piers at San Francisco

New System, with Fenders out of Reach of Borers, Expected Greatly to Reduce Maintenance—Piers Typify Arrangement to Suit Tenants

By FRANK G. WHITE
Assoc. M. Am. Soc. C. E.; Assistant Engineer, California State Harbor Commission

SUSPENDED fenders, instead of the usual driven type, are a feature of the new piers 30 and 32 at San Francisco, construction features of which were described in the Engineering Record of Dec. 6, 1913, page 633. As the old type of fender is very much at the mercy of marine borers and cannot be adequately protected by preservative treatment on account of the rapid mechanical wearing down of the timber to the untreated wood, the innovation at piers 30 and 32 is expected to cut down greatly what has heretofore been the chief maintenance item of concrete piers in this vicinity.

In other respects piers 30 and 32 are typical examples of the reinforced-concrete cylinder type of construction, arranged to suit the tenants, and may be used to explain the plan followed in all the piers recently completed. A block-letter U is formed by these two piers and their connecting wharf, so that four berths are provided, arranged in this case to suit the needs of the tenants, the American-Hawaiian Steamship Company. The U is constructed as a unit, the pier width being 200 ft., and the berthing slips being 222, 555, 720 and 807 ft. long, respectively.

The pier sheds are 156 ft. 7 in. in width, leaving room outside for a railroad track on each side of each pier. This location for the tracks was decided upon so as to permit of direct interchange of freight between ship and car and also to avoid the congestion caused by cars operating near the driveway in the center of each pier. In order to facilitate trucking into freight cars, one track on each pier is depressed 3½ ft. so as to bring the car floor practically to the level of the deck.

Live and Dead Loading

The deck and supports of the pier are designed for full dead load and a uniformly distributed live load of 500 lb. per square foot. The beams and girders under the railroad tracks are designed to carry a 75-ton switch engine followed by a uniform load of 5000 lb. per linear foot of track, with an allowance of 50 per cent additional for impact.

Piers 30 and 32 rest on compact beds of clay, sand and gravel which have been tested without settlement with loads of more than 15 tons per square foot. The bases of the cylinders under these piers are designed to carry loads of 5 tons per square foot. In designing the reinforced-concrete deck and supports the recommendations of the joint committee on concrete and reinforced concrete were followed. On the basis of 2000-lb. concrete the unit stresses used were 650 lb. per square inch for concrete and 16,000 lb. per square inch for reinforcing steel.

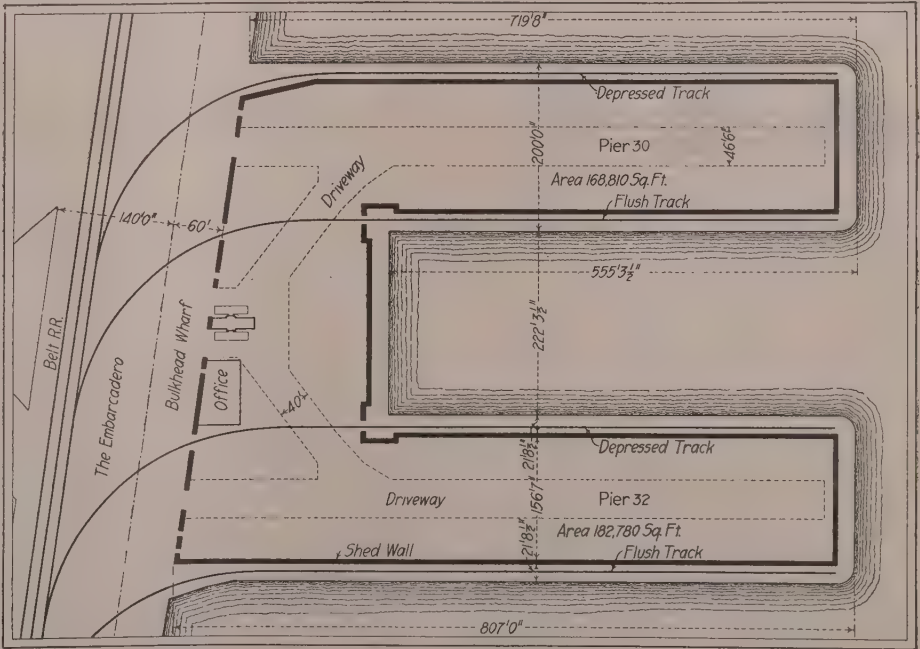
The concrete cylinders supporting the main portion of the piers are spaced on an average about 15 ft. apart in both directions. The lengths vary from 50 to 75 ft. and the diameters from 3 to 4 ft. The cylinder reinforcement consists of ¾-in. and ⅞-in. vertical bars with spiral hooping of ¼-in. wire on 6-in. centers, from eight to fourteen bars being used in a cylinder. The reinforcing is placed 3 in. from the outside of the cylinders and extends to the bottom of the bases.

The deck consists of a 5-in. slab, reinforced with ⅜-in. square deformed bars, resting on heavy girders supported at right angles to the axis of the pier and connecting with longitudinal beams that frame into the cylinders and into the girders at the third points. The beams and girders are fully reinforced for shear and the girders are securely tied into the cylinders with deep haunches. On the flush-track side the track beams and girders are covered with a slab to permit of ballasting and paving; but on the depressed-track side the deck is left open and the ties rest directly on the longitudinal concrete beams beneath the rails.

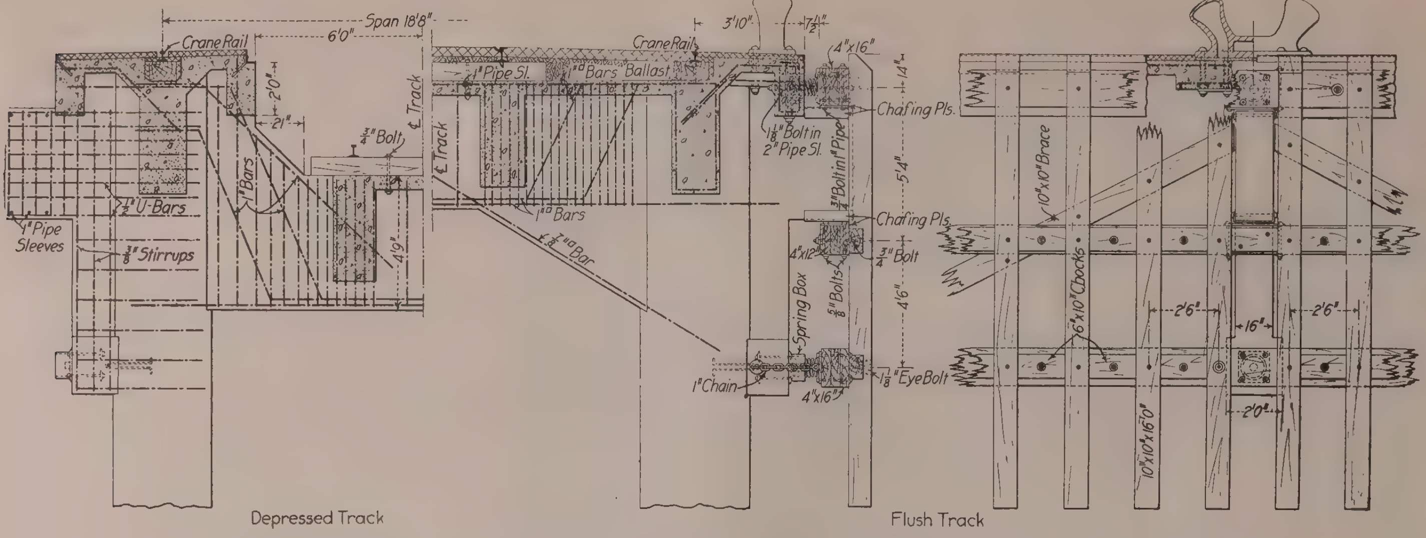
Pier Sheds

The pier sheds are built entirely of timber except for the outer rows of columns, for which steel plates and angles were used. There are four lines of crane girders and rails inside each shed to accommodate cranes serving the outside bays. The center bay is designed to carry a system of telpher tracks which run from pier to pier over the connecting wharf.

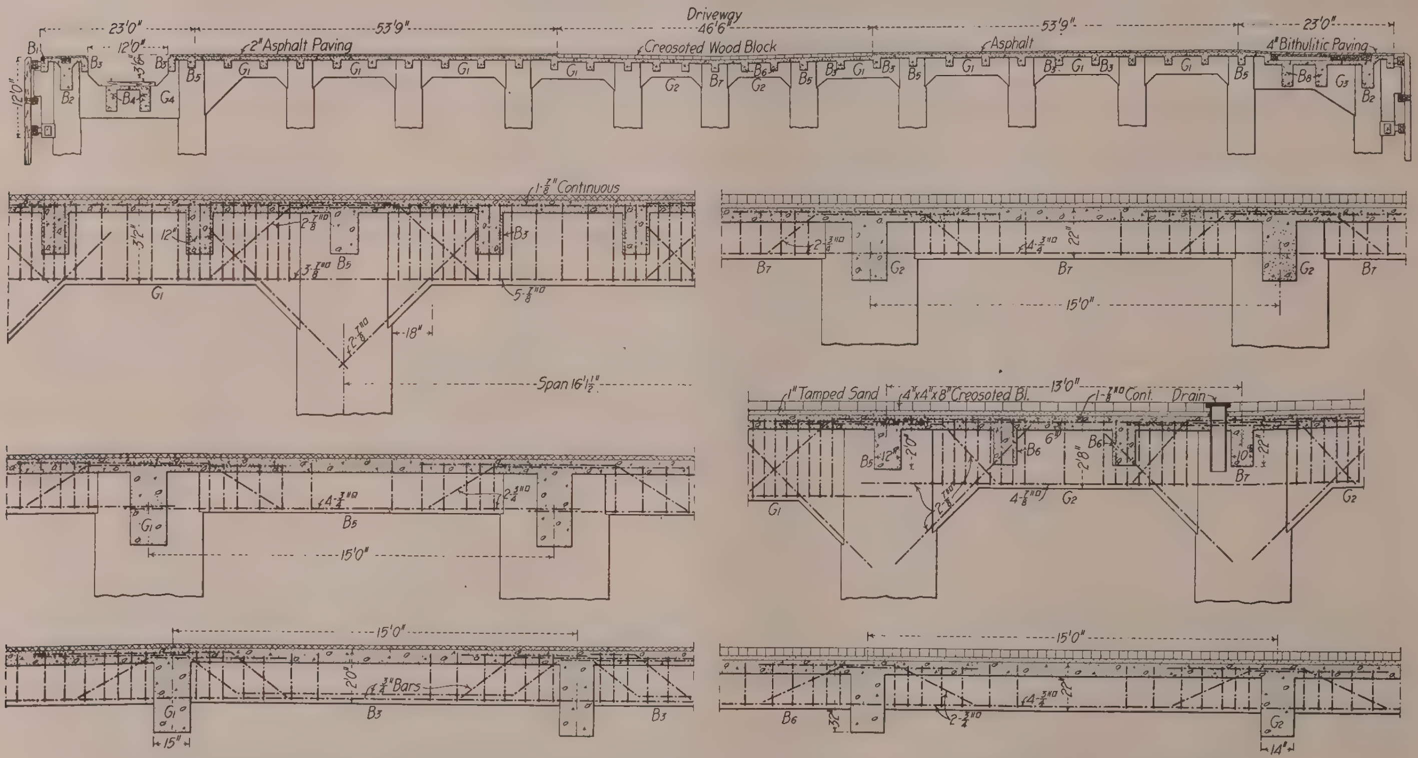
The sheds are 27 ft. high to the under side of the trusses, allowing ample space for stacking cargo by means of cranes. Bracketed out from the columns on each side of each shed is another line of crane girders designed to take the inner bearing of a semi-portal crane, whose outer legs rest on a rail on the pier deck. The girder is above the door openings and the cranes will span the railroad tracks and by means of an extension boom will be able to take the cargo direct from the ship's hatches. The



GENERAL ARRANGEMENT OF PIERS, SHEDS, TRACKS AND DRIVEWAYS



STRUCTURAL DETAILS OF SUPPORTS FOR DEPRESSED AND FLUSH TRACKS, AND OF SUSPENDED FENDERS

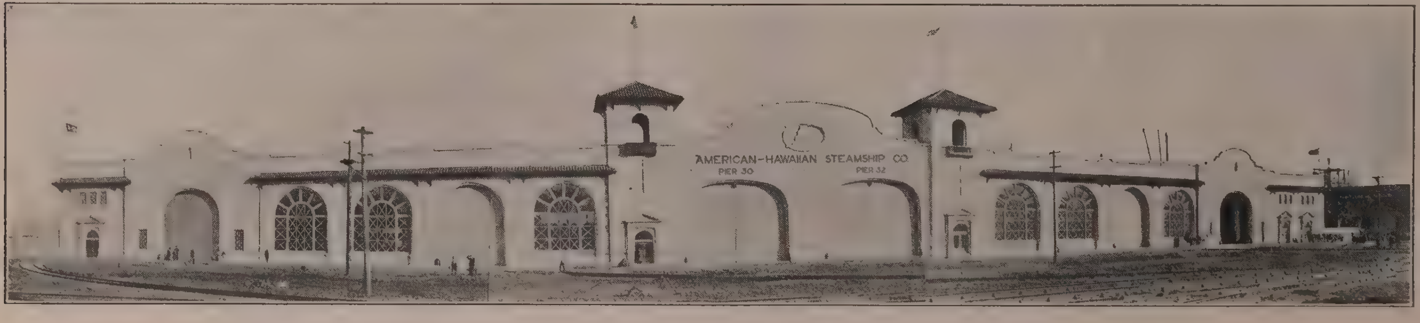


GENERAL TRANSVERSE SECTION OF PIER AND DETAILS OF REINFORCED-CONCRETE BEAMS AND GIRDERS

sheds and piers were designed to carry cranes and telphers having a capacity of 5 tons, at the request of the steamship company, and with the understanding that the company would install the equipment.

The sides of the sheds are provided with continuous openings that can be closed with Kinnear steel rolling doors. Each opening is 22 ft. in height and 30 ft. wide from center to center of columns. In order to avoid an extremely large curtain, each door is in two sections with a movable center post which is mounted on grooved wheels at the top and runs on a track supported by one of the crane girders. When the doors are raised the post is moved to its open position against the main column by means of a hand line, and it is returned to its closed position by a counter-weight sliding in guides alongside the column.

The modified mission type of architectural treatment was adopted for the shed fronts on four of the new piers south of the Ferry Building, and the improved appearance of the Embarcadero is thought to justify fully the comparatively slight addition to the pier cost. The shed fronts are



TYPE OF ARCHITECTURAL TREATMENT ADOPTED FOR THE NEW STATE PIERS AT SAN FRANCISCO of timber, covered with metal lath and Portland cement plaster, the two central towers and the heavy cornice being covered with mission tile.

SUSPENDED FENDERS

The prevalence of the teredo and limnoria in the bay waters limits the life of green fender piles to from six months to a year, and creosoted piles in a fender line are subjected to such rough usage that they are worn down to the untreated wood in a comparatively short time. These conditions make fender maintenance the most important item in pier upkeep. Accordingly, in designing the new piers it was decided not to use the usual driven-pile fenders, but to develop another type that would be free from their objectionable features. Suspended fenders were therefore decided upon. They consist of three lines of ribbing built up of creosoted lumber and carrying vertical sheathing of green timber, the whole being supported by reinforced-concrete cantilevers projecting out from the cylinders on the lines of the main transverse girders.

Triple car springs, placed behind the upper and lower lines of ribbing at each row of cylinders, thrust against heavy cast-iron plates on sockets in the concrete. The springs allow a movement of 3 in., the fender line sliding on chafing plates on the ribbing and the concrete cantilevers. The sheathing timbers are 10 in. square and 16 ft. long and are spaced 2½ ft. apart center to center by chocks at each line of ribbing.

The mooring bitts, which are spaced about 60 ft. apart, are heavy iron castings of a pattern specially designed to prevent the lines from slipping off when run up at a steep slope. They are secured to heavily reinforced concrete beams by bolts running through pipe sleeves so as to permit of removal in case of damage.

PAVEMENT

The driveways on these piers are paved with wood blocks 4 in. in thickness, laid on a 1-in. sand cushion, the joints being grouted with asphalt. The blocks are Douglas fir treated with avenarius carbolineum and the pavement is laid under a ten-year guarantee. The driveways on piers 26 and 28 have been paved with creosoted blocks and that on pier 39 with blocks of Ohio wood, a very hard wood from the Hawaiian Islands. Along the railroad tracks bituminous rock pavement was used, and the remaining area was paved with sheet asphalt.

The total cost of piers 30 and 32 was $1,256,162, or approximately $3.60 per square foot of deck area. They were begun June 25, 1912, and were completed and accepted Dec. 1, 1913. The plans were prepared under the direction of A. V. Saph, chief engineer. Soon after the construction began Mr. Saph was succeeded by the present chief engineer, Jerome Newman. Carl Uhlig and the writer were assistant engineers and H. M. Kebby was chief inspector. The contractor was the Pacific Wakefield Company.

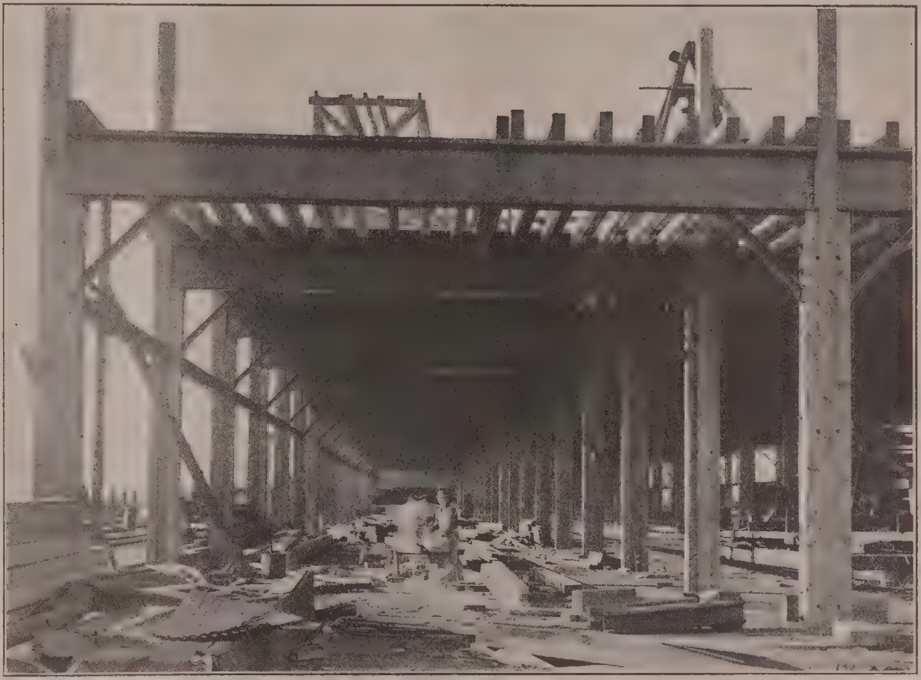
A 16,000-HP HYDROELECTRIC PLANT is in course of construction near Cacheuta, Argentina. This plant, the cost of which is estimated at $1,500,000, has a tunnel 10¾ ft. wide, 12¼ ft. high and 7283 ft. long, of which about 4000 ft. has been built since the construction was begun last May. The plant is being built by Compania Luz y Fuerza, of Mendoza, Argentina.

Column Design for Steel and Wood Construction

System Used by Port of Seattle Commission Combines Strength and Rigidity with Low Cost and Chance for Speedy Erection

TAKING advantage of the low price of lumber in that vicinity the Port of Seattle Commission, in the erection of a two-story shed on the waterfront adjacent to the municipal grain elevator now under construction, has worked out a combination of wooden columns and steel floorbeams, securing a strong, rigid structure that could be erected speedily and at low cost.

The accompanying illustration shows the arrangement. There are two rows of interior columns of the same dimensions, while larger timbers are used in the outer walls. All three are spanned by 30-ft. Bethlehem special I-beams 28 in. deep and weighing 165 lb. per foot. The interior columns are built up of a central 10 x 10-in. post, flanked by two 6 x 10-in. timbers, while the outer columns consist of a full-length 10 x 12-in. post keyed to a 8 x 10-in. timber that supports the end of the girder. The keys consist of 2-in. galvanized iron pipes, held in place by ⅞-in. bolts.



STRENGTH AND RIGIDITY COMBINED WITH LOW COST AND FACILITY OF ERECTION

The advantages claimed for this construction are that it is better than one continuous column clear to the roof trusses because it saves material and gives simpler connections for the girders; that by continuing one timber through the roof trusses there is obtained a column practically fixed at the second-floor level, which is of advantage in resisting horizontal wind stresses; that by using a column built up of smaller timbers it is possible to get a better grade of timber than could be obtained in larger sticks, and finally that the smaller timbers are likely to check less when drying out than the larger timbers would.

In erecting the structure the contractors used two stiffleg derricks. One of these worked on the floor of the wharf, setting the columns, steel girders and second floor joists, and this work was immediately followed up by a second derrick traveling on the second floor, erecting the roof trusses and purlins, and placing lumber and other material for the roof. On the whole, the design is reported to have lent itself readily to very speedy construction.

About 2,000,000 ft. b. m. of lumber was used in the shed, the average price being $12 per thousand. The total floor area for the two stories is 171,398 sq. ft. The structure was designed and the construction carried out under the direction of J. R. West, acting chief engineer of the Port of Seattle Commission.

Building a 3000-Mile Highway System for $18,000,000

ROAD construction problems in California extend over a wide range of service conditions because part of the system is in rugged mountainous regions in the north, while other sections cross the warm sandy plains of the south. Perhaps the most interesting problem, however, was the all-important one of how to build 3000 mi. of highways on a total appropriation of $18,000,000. The State highway act, under which an appropriation of this amount is being expended, allows considerable latitude in its definition of the roads to be built but calls for the construction of about 1800 mi. of trunk roads, and 1200 mi. of laterals connecting county seats with the trunk routes.

Early in the work, which has been under way since 1912, six fundamental principles were decided upon as follows: (1) A right of way not less than 60 ft. in width, where it is reasonably possible, and as direct between objective points as is consistently possible. (2) Gradients not exceeding 7 per cent, even in the mountainous parts of the State. (3) Curves as open as possible and in no case of less than 50 ft. in radius. (4) As many culverts of sufficient capacity as are needed to take care of surface and underground water. (5) A traveled way, under ordinary conditions, not less than 21 ft. in width, and in the mountains not less than 16 ft. wide, with the center paved or surfaced so as to be hard and smooth under all climatic conditions at all times of the year, the width of surfacing to be in general 15 ft. (6) Smoothly graded roadsides, reserved for future tree planting.

The construction of the new highway system in California has been described from time to time in the Engineering Record, notably in an article by Austin B. Fletcher, chief engineer of the California Highway Commission, which appeared in the issue of Nov. 7, 1914. A detailed statement of progress up to Jan. 15, 1915, is summed up in the accompanying tables.

STATUS OF CALIFORNIA HIGHWAY WORK, JAN. 15, 1915

	Miles
Surveys made	2150
Layouts made	1101
Contracts advertised or awaiting award	35
Contracts let, including day labor, (121 contracts; 19 day-labor jobs)	1008.5
Work completed and accepted	382
Work completed but not yet accepted	250

DETAILS OF WORK COMPLETED OR UNDER CONTRACT

	Miles
Graded only	270.1
Waterbound macadam	12.9
Oil macadam	19.1
Cement concrete (thin bituminous top)	664.3
Macadam	16.5
Cement concrete (asphaltic top)	20.9
Timber and concrete trestle	4.4
Bituminous concrete	0.3
Total	1008.5

CONSTRUCTION IN THE YEAR 1914
Pavement laid (min. thickness 4 in.)

	Miles
12 ft. wide, Portland cement concrete	6
15 ft. wide, Portland cement concrete	208
18 ft. wide, Portland cement concrete	43
20 ft. wide, Portland cement concrete	8
24 ft. wide, Portland cement concrete	5
Macadam waterbound	4
Macadam oilbound	3
	277
Graded roads	142
Total	419

SURFACING

	Miles
Thin bituminous	85
Asphalt	21
Number of contracts	72
Miles completed or under construction, about	1008

ELECTRIC HAULAGE has been substituted for horses in the Harecastle Canal tunnel in England, according to a recent consular report. The tunnel, which was built in 1827, is 14 ft. wide, in addition to a 5-ft. towpath. Owing to mining subsidences the towpath was in some places under water, and horse haulage had become difficult. Under the new system there are several storage-battery towing barges, each of which can haul seventeen barges with 22-ton loads through the 1 2/3 mi. of tunnel in forty minutes. Each towing barge can store sufficient power for several journeys.

DUMPING A TRAIN AT THE EAST END OF THE 1,000,000-YARD FILL

Spokane Terminal Improvement Involved Variety of Engineering Construction

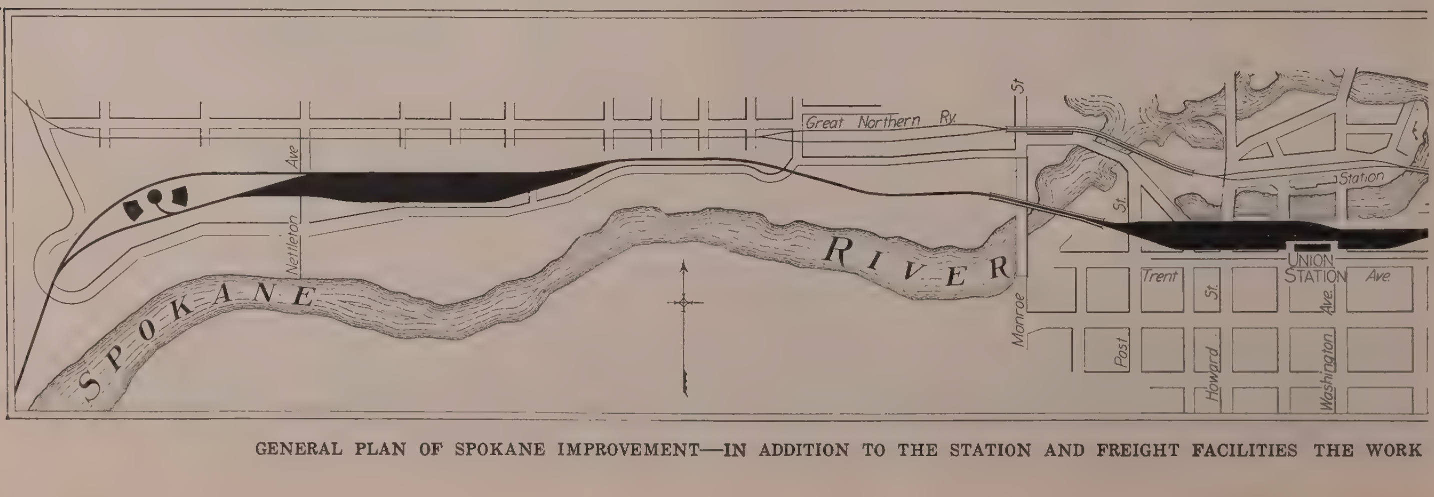
Special Features of Joint Project of Chicago, Milwaukee & St. Paul Railway and Oregon-Washington Railroad & Navigation Company

JOINT TERMINALS of the Chicago, Milwaukee & St. Paul Railway and the Oregon-Washington Railroad & Navigation Company at Spokane, Wash., were opened last September, as announced in the "Current News" of this journal. The work, which involved, in addition to the terminals themselves, some 3½ mi. of double track without grade crossings, was done under a joint agreement between the two companies, whereby the former company was to handle that east of the station and the latter, the station and the work from there west. An 850 ft. subway and eighteen bridges, including one 768 ft. long over the Spokane River, were built. Heavy grading was also required.

Prior to the beginning of this improvement the St. Paul had no line into Spokane, the Puget Sound extension passing about 35 mi. south. By the construction of a 20-mi. connection to the east of the city, and a traffic arrangement for the use of certain Oregon-Washington Railroad & Navigation Company tracks both east and west of the city, the St. Paul is given a detour permitting its trans-continental trains to pass through Spokane. The advantages to the Oregon-Washington Railroad & Navigation Company are relief from part of the expense of eliminating grade crossings and providing an attractive terminal for the new short line to Portland as well as for the company's older lines entering the city, and rental for trackage rights over about 80 mi. of line.

EXTENT OF IMPROVEMENT

Washington Street forms the dividing line between the sections handled by the two companies. The section built by the Chicago, Milwaukee & St. Paul extends from Napa Street to Washington Street, a distance of 9700 ft. From Napa Street to Erie Street all streets are carried under the railroad. At Erie Street the road passes over the Spokane & Inland Empire Railway. Thence the grade drops, passing over the south bend of the Spokane River, in which a 200,000-yd. rock fill was made in 47 ft. of water. West of this point a double-track subway 850 ft. long passes under Trent Avenue car tracks of the Washington Water Power Company and transfer tracks of the Northern Pacific and Great Northern Railways. The line then passes under Market Street and the Spokane & Inland Empire Railway at that point, under Division Street and under other tracks of the Washington Water Power Company. At this point it rises, passing over Center Street and spreading out east of Washington Street on a steel and reinforced-concrete structure to form the east approach to the terminal. West of Division Street freight tracks leave



GENERAL PLAN OF SPOKANE IMPROVEMENT—IN ADDITION TO THE STATION AND FREIGHT FACILITIES THE WORK

TWO-BOOM TRAVELER ERECTING A TRUSS SPAN OF THE MONROE STREET VIADUCT

LANDING THE 110-FOOT GIRDERS THAT CLOSED THE GAP OVER THE MONROE STREET ARCH

the main line, descend to a grade crossing at Center Street, and lead to a freight house and team tracks at the street level.

The work handled by the Oregon-Washington Railroad & Navigation Company extends from the east line of Washington Street to the east abutment of the viaduct over Hangman Creek, a distance of 9000 ft. The wide structure carrying the station tracks continues west from Washington Street to Post Street. At Post Street the track layout tapers down to the main tracks, and just west of this point a double-track steel viaduct carries the line over the Spokane River at a height of 165 ft., also clearing by 20 ft. the city's Monroe Street concrete arch bridge over the river. From this bridge to Hangman's Creek, a distance of 6700 ft., the tracks are carried on a fill containing 1,000,000 cu. yd., the streets being carried underneath.

Freight facilities will be provided for this road west of the Monroe Street viaduct. A freight house will be built at Monroe Street, and beyond the local freight yard will be an engine terminal and machine shop.

THE STATION

The station, which, it will be seen, is about midway of the improvement, is a four-story structure with two one-story wings; it is 300 ft. long over all and 52 ft. wide. It is of steel incased in concrete and faced with tapestry brick, Indiana sandstone, terra cotta and polished marble. On the ground floor are the lobby, dining room, hospital and second-class waiting room. The main waiting room is on the floor above. From it a concourse leads under all the tracks, which are slightly above the waiting room and are reached by stairways from the concourse to each platform.

Five through tracks, together with three stub tracks at each end, serve the station. The pairs of tracks are on 12½-ft. centers. The main island platforms are 19½ ft. wide, the stub platforms being narrower.

The station viaduct spans five streets, giving 14 ft. clearance. Its steelwork is carried on concrete piers, which run down to solid rock except in one block, where Raymond concrete piles were driven to support the piers. The deck of the viaduct is of reinforced concrete waterproofed with an asphalt mastic. Umbrella sheds shelter the platform. Before erecting the viaduct it was necessary to tear down and remove four blocks of brick buildings, including the city hall.

ERECTING MONROE STREET VIADUCT

The railroad company's Monroe Street viaduct, as distinguished from the city's Monroe Street bridge, is 768½ ft. long, made up of one truss span of 195 ft. and one of 160 ft., a girder span of 110 ft., one of 83½ ft. and two of 50 ft., with 30 ft. towers carried on reinforced-concrete piers resting on solid rock. It has a reinforced-concrete deck.

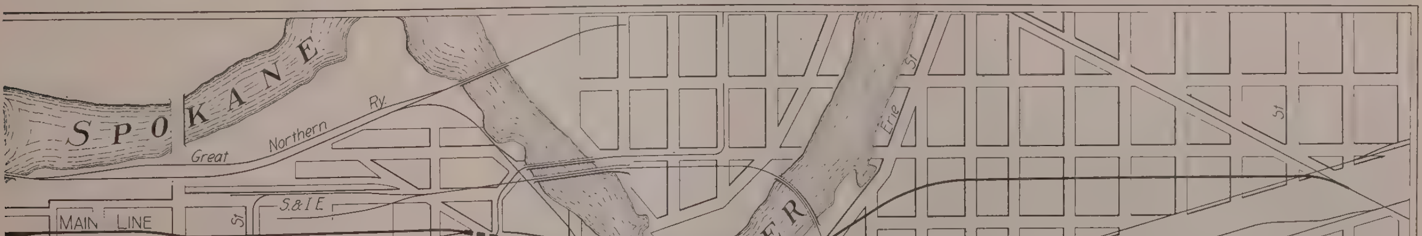
The spans at the west end up to the 110-ft. girder span were placed from that end by a crane traveling on the bridge as it was completed. At the same time work was carried on from the east end with a two-boom traveler. The 160-ft. span was erected on falsework and the 195-ft. span was erected as a cantilever. When all but 30 ft. of this longest span was completed the bent to support it was erected from its end. The span was then completed and the 110-ft. girders were swung into place from the west end. The steelwork was completely erected and riveted in eighty days, working two eight-hour shifts, and in twenty days more the concrete deck was entirely placed.

TRENT AVENUE SUBWAY

Next in importance of the structures is the 850-ft. Trent Avenue subway on the Chicago, Milwaukee & St. Paul section of the work. The subway is of the slab type of construction, with a span of from 29 to 45 ft. and walls from 12 to 22 in. thick. The work involved the excavation of 46,000 cu. yd. of solid rock, in which extreme care was required to avoid damage to a brewery only 16 ft. distant from the cut, and the relocation of a 24-in. sewer alongside the excavation to the Northern Pacific-Great Northern transfer bridge, at which point it was dropped into a manhole and carried under the subway to the river.

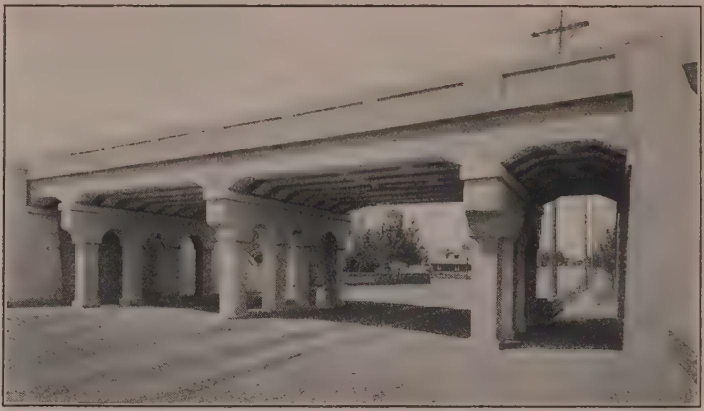
The concrete for the subway was poured from a single plant, located in the center of the work. The aggregate was unloaded from cars by a clamshell bucket and fed into a ¾-yd. Smith mixer from a 30-yd. hopper. From the mixer the concrete was handled in Koppel cars and dumped directly into the forms. As the work was done in the winter all material was heated; the forms were covered with canvas and the temperature was kept constant by steam.

In order to avoid a grade crossing at Division Street it was necessary to raise



INVOLVES HEAVY GRADING, AN 850-FOOT SUBWAY, A BRIDGE OVER THE RIVER AND NUMEROUS SMALLER BRIDGES

AT EAST END OF IMPROVEMENT BRIDGES WERE NUMEROUS


ONE OF FIVE ORNAMENTAL BRIDGES WITH FOUR-POST BENTS

the street 11 ft. at its intersection with Trent Avenue. As Division Street is the main artery from the business section of the city to the populous north and northeast sections, and as there was absolutely no other route by which travel could be diverted, it was necessary that provision be made to take care of the traffic during the regrading. This was done by carrying the street around the work on trestles on the company's land.

The regrading necessitated the raising of four water mains. Two, of cast iron, 12 and 16 in. in diameter respectively, were raised by being jacked as a unit and supported on small timber bents during the process of filling. The other two were high-pressure mains, with respective diameters of 24 and 30 in., carrying the water supply for the city's business center and south side. It was necessary to build new pipes and carry them in their permanent location on temporary trestles, connect them up at the ends with the old mains and salvage the abandoned sections of the latter.

TYPES OF CONSTRUCTION

All told, including crossings at streets and alleys, there are eighteen bridges on the improvement besides the streets crossed by the station viaduct, all of which, with the exception of five timber bridges at the east end of the improvement, are of permanent construction, mostly of the plate-girder and slab-deck type, with either plain or reinforced and counterforted concrete abutments. Where intermediate piers have been used they are in general four-post arch bents, as shown in one of the illustrations. The alley crossings are of the slab culvert type, supported by vertical barrel walls, strutted at the base, with cantilever wing walls. The Northern Pacific-Great Northern transfer bridge has an I-beam deck incasement, supported at each end and in the center by a reinforced-concrete wall. The bridge is contiguous with the Trent Avenue subway.

Retaining walls were necessitated along a large part of the improvement to hold the slopes. Some of these are of reinforced concrete, cantilevered, while others are cyclopean, of the gravity type.

PERSONNEL

The work east of Washington Street was designed and executed under the direction of the engineering department of the Chicago, Milwaukee & St. Paul Railway—in its preliminary stages by E. J. Pearson, chief engineer, and later by C. F. Loweth, chief engineer; E. O. Reeder, assistant chief engineer; George Rice and A. G. Holt, division engineers, and L. M. Chase, resident engineer, of the Chicago, Milwaukee & St. Paul Railway.

The work from Washington Street west was designed and executed under the direction of the engineering department of the Oregon-Washington Railroad & Navigation Company—in its preliminary stages by John D. Isaacs, consulting engineer, and later by E. E. Adams, consulting engineer; J. R. Holman, chief engineer; J. D. Isaacs, Jr., terminal engineer, and H. M. Sheerer, assistant engineer.

The Bates & Rogers Construction Company, of Chicago, had the general contract for the work east of Washington Street, including the concrete bridges, the subway and the rock excavation, and also the contract for the concrete work west of Washington Street. F. L. Copeland was superintendent on both contracts. Grant Smith & Company, with F. W. Hinsdale as superintendent, erected the station and track viaduct. Other contractors on the section west of the station were the Twohy Brothers Company, John D. Twohy, Jr., superintendent, for the grading; the General Construction Company, D. G. Munro, superintendent, for the grading, and Wakefield & O'Neil for the bridge erection.

PIPES AND TROLLEY TRACKS COMPLICATED THE WORK AT DIVISION STREET

Compressive Strengths of Concrete Test Blocks

THE compressive strengths of concrete test blocks made in Cleveland from bank sand, river sand and lake sand were found to have the following ratios:

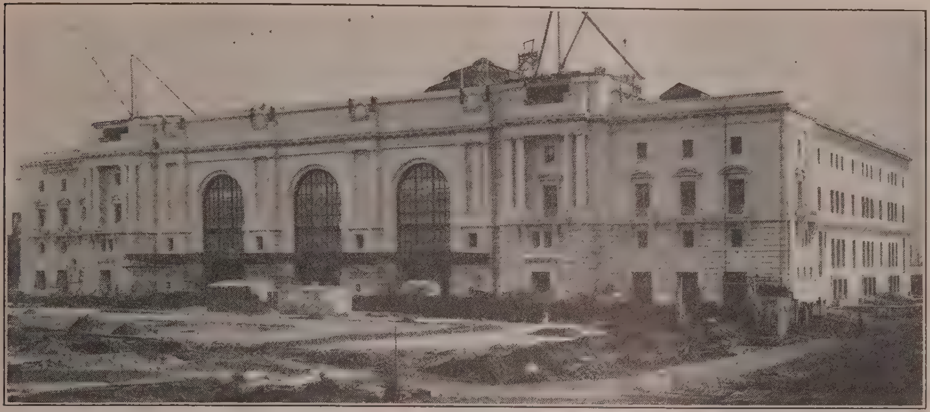
Bank sand to river sand	30 : 20
River sand to lake sand	20 : 18.7
Bank sand to lake sand	30 : 18.7

Comparing the densities of concrete blocks made of the same sands, the following ratios were obtained:

Bank sand to river sand	13 : 12
River sand to lake sand	12 : 11
Bank sand to lake sand	13 : 11

In obtaining a more accurate comparison between compressive strength and absorptive power a curve was plotted with the percentage of water absorbed as abscissæ, and compressive strength in pounds per square inch as ordinates. The curve drawn through the mean position of the plotted points is an hyperbola the equation of which is $S = 5400/A$, where S equals unit strength and A, water absorbed in per cent.

REVENUE FROM SEWAGE DISPOSAL is one of the subjects discussed in the "Surveyor's" annual review of progress in sewage treatment in England. It is stated that there are few places where any income is derived from sewage, and among these Bradford, Yorks, probably stands easily first. Although the total cost of disposal in 1913 was £89,000, the sale of grease alone brought in £48,000, while the sludge residue, after the removal of the grease, was sold in large quantities as manure, being sent to France, Belgium, Florida, and even as far as India for tea gardens on the slopes of the Himalayas. The revenue derived from the sale of these by-products more than covers the cost of operation, so that, apart from capital charges, the sewage disposal works are self-supporting.



EXTERIOR APPEARANCE OF EXPOSITION AUDITORIUM AT SAN FRANCISCO

Ventilation and Other Features of Exposition Auditorium at San Francisco

Elaborate Fan System in Building Specially Designed for Conventions and Congresses—Seating Capacity of 11,000 in Octagonal Main Hall

HEATING and ventilation of a large main hall in which there must be no floor obstructions that would interfere with turning it into a great ballroom was one of the problems presented in the design of the exposition auditorium at San Francisco. The problem was solved by a double fan system, in which air is forced downward through the hall at a high velocity and upward at a low velocity.

More than 400 conventions and congresses are already scheduled to convene in San Francisco this year, and in anticipation of these those who planned the exposition made provision for ample convention room suitable for large and small gatherings. It was found that to meet the requirements adequately a more substantial building than the temporary exposition structures was desirable, and accordingly the exposition company arranged to build a permanent structure in the civic center, described in the Engineering Record of Oct. 31, 1914, page 489, which would be suitable for convention purposes during the exposition, and which would afterward become the property of the city. This plan was carried out, and on Jan. 9 the completion of the $1,300,000 auditorium was celebrated by a ball at which an attendance of 17,500 was successfully handled.

The building is a class A structure, four stories in height, having plan dimensions of 402 x 268 ft. The main auditorium, octagonal in shape and 222 x 254 ft. in plan, occupies the center of the structure and utilizes its full height. The dome of this hall is not carried by the frame of the building, but rests on a circular I-beam 200 ft. in diameter, supported by eight columns, as shown in one of the accompanying illustrations. The steelwork of the dome has been left exposed as shown, but the supporting columns have been finished to harmonize with the white walls.

ARRANGEMENT OF CONVENTION HALLS

Flanking the main hall on either side are fourteen smaller rooms, which can, by the use of partitions, be subdivided so that in all twenty-six meeting rooms can be used simultaneously if desired. Two of these smaller rooms on the main floor are 56 x 136 ft. in plan, each having a height of two stories, and are intended to be used as banquet halls. The smallest rooms are on the fourth floor. The space in the basement is occupied by a large kitchen, machinery and chair storage rooms, toilets, lockers and space for the stabling of horses. From the latter space an incline leads to the floor of the main auditorium.

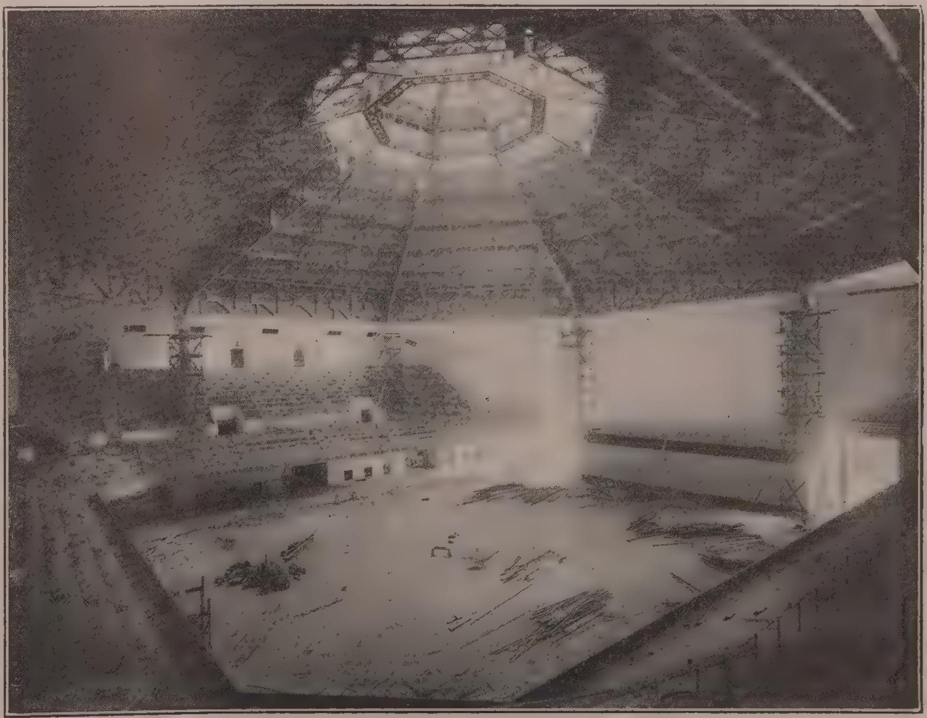
The main auditorium has a seating capacity of 5000 on the ground floor and 6000 in the balconies. The large balcony capacity was planned because of the many gatherings at which the main floor would be used for exhibits or other purposes, limiting the spectators to the capacity of the balcony. The balcony seats are therefore permanent, while those on the main floor will be placed and removed as required.

A telephone system connecting all halls and corridors with a central station has been installed, and plugs at convenient points enable a floor manager to communicate with switchboard, stereopticon box and box office. A manager's call-bell system connecting all parts of the building with the central station is also provided. There are twenty-five street entrances and forty-one double doors for emergency exit. Twelve wide stairways lead upward from the lower corridors and provide direct access to each section of the balconies.

HEATING AND VENTILATION SYSTEM

The maintaining of an even temperature in the main auditorium and supplying of ample fresh air to a throng of 11,000 people gathered there presented problems of a rather unusual nature, and these were enhanced somewhat by the necessity of keeping the ground floor free of registers so that it could be converted into a ballroom. The solution of the problem was found in the use of a double circulation system. This is so arranged that after being filtered and warmed, air is forced out from the lower rim of the balcony at high velocity and passes downward to exhaust vents near the floor connected to exhaust fans in the basement, while a secondary circulation is maintained by forcing air into the room at a low velocity from beneath the balcony seats and drawing it out through exhaust registers in the balcony ceiling connected to exhaust fans on the roof.

Fresh air for the entire building is taken from the roof through two vertical shafts 8 x 18 ft. in cross-section, and after passing through air washers in the basement, is drawn into the fans, to each of which is attached a Vento heating coil of corresponding capacity. In all eighteen motor-driven fans are used in forcing air through supply and exhaust ducts, twelve being located in the basement and six on the roof. The fresh-air supply for the main auditorium is handled by two fans with capacities of 145,000 cu. ft. per minute that discharge through the register in the balcony railing and also into the chamber under the balcony seats. A high delivery velocity is maintained through the balcony railing registers by continuing the ducts from the fans direct to the openings, and at the same time a low velocity is secured in the



SEATS FOR 11,000—UNFINISHED INTERIOR OF OCTAGONAL MAIN HALL vents beneath seats, which simply discharge from the large inclosed space under the balcony floor.

The exhaust openings in the ceiling and near the floor, shown in the accompanying photograph, are connected to two fans in the roof with capacities of 70,000 cu. ft. per minute and two in the basement with capacities of 75,000 cu. ft. per minute. The two banquet halls on the first floor are each supplied with fresh air by two smaller fans in the basement and exhausted by two, also in the basement; their capacities are respectively 30,000 and 33,000 cu. ft. per minute. To prevent down drafts from the high windows in the banquet rooms, semi-indirect radiators were placed in pockets in the walls underneath each window. Corridors on the first floor are supplied with fresh air by two fans with capacities of 15,400 cu. ft. per minute, located in the basement.

From the basement the exhaust air passes through two concreted tunnels 6 x 10½ ft. in section to exhaust air shafts to the roof that are 7 x 19 ft. in section. Air is also exhausted from toilet rooms and the kitchen by fans that have a total capacity of 39,000 cu. ft. per minute.

The entire plant is calculated to effect a maximum rise in temperature in the air handled of 54 deg. outside temperature and 94 deg. temperature of air delivered. Except for the two concrete tunnels, galvanized iron ducts are used throughout, some of these being as large as 120 x 21 or 60 x 80 in. in section. Static water pressures of from ½ to 1¼ in. are maintained by the various fans, and the maximum velocity in the ducts is about 1800 ft. per minute. The velocity at the outlet of the larger blowers is 2400 ft. per minute. In the air washers the maximum velocity is 375 ft. per minute.

Direct radiation is not used in the main auditorium except to prevent down drafts at the rear walls. The committee and exhibition rooms on the third and fourth floors are heated by direct radiation piped for a two-pipe vacuum system. Steam from the central steam generating plant in the civic center will be used in the direct and indirect systems.

LIGHTING SYSTEM

The main auditorium is lighted principally by forty-eight 500-watt tungsten lamps set in reflectors around the edge of the octagonal glass lantern in the center of the dome. These lights are 95 ft. above the floor and their location and arrangement is effective because the main hall is practically in the form of a section of a sphere. It was necessary, however, to place lighting units above the rear balconies and under the front balconies in order to overcome shadow effects. For these units, as in all the smaller halls and corridors, semi-indirect fixtures are used.

The various lighting circuits are controlled from a central switchboard in a room near the entrance on the first floor and in most cases there are also local switchboards so that any one of three degrees of illumination may be had in the several separate rooms. Exterior decorative lighting has been limited to outlining the under side of the marquise and illuminating the three main arches in the façade facing the civic center plaza. These arches extend from the first to the fourth floors and are fitted with double glass sash having an intervening space of about 2 ft. In this space 5-watt frosted lamps are spaced 9 in. apart and give an even illumination over the frosted glass which prevents shadows from within.

The plans for the exposition auditorium were developed under the direction of J. G. Howard, F. H. Meyer and John Reid, Jr., acting as a board of consulting architects for the city. The heating and ventilating plant was designed by Hunter & Hudson, consulting engineers, and the lighting features were worked out by W. W. Hanscom, consulting electrical engineer.

Municipal Plant Reduces Asphalt Maintenance Cost in New York

H. W. Durham, Chief Engineer, Bureau of Highways, States that City-Owned Plant Repaired Pavements at 99.8 Cents a Yard against $1.47 by Contract

BY installing, in May, 1914, a municipal asphalt plant—claimed to be the largest city-owned installation of its kind in the world, as regards capacity—the cost of pavement repairs in the borough of Manhattan, New York City, has been reduced from $1.47, the average price by contract during the year, to 99.8 cents per square yard, the latter figure including an item of 18.4 cents for overhead and depreciation. The actual saving on yardage made last year by the municipal plant was $61,626. This saving was possible in spite of the fact that the municipal plant used Portland cement instead of limestone dust as a filler, sand at 80 cents a yard instead of the 50-cent sand employed by the asphalt companies, and crushed stone at a price in excess of $1 per cubic yard, which was paid by the contractors. The design of the plant and the economy effected during the seven months of its operation are discussed in detail by Henry W. Durham, chief engineer during 1914 of the Bureau of Highways of the Borough of Manhattan.

ARRANGEMENT OF PLANT

The plant is located at Ninetieth Street and the East River. At the waterfront a Meade-Morrison hoist, equipped with a 42-cu. ft. grab bucket operated on a wooden mast and boom elevates material to a point of discharge into a hopper at a tower located at the end of three wooden trestles leading to bins where sand, stone and coal are stored. From the hopper sand and stone are delivered into automatic side-dump cars which discharge through openings in the roof of the building to large storage bins. The material passes through rotary driers and is discharged at the foot of a bucket elevator which conveys it to hot sand and storage bins. The sand passes through a rotary screen and into the bin. Tailings are conveyed to the ground floor by a stone elevator where they are used in the making of binder or for concrete. Hand-operated gates at the bottoms of the storage bins make possible the discharge of the desired amount of material into weighing boxes.

There are three asphalt melting kettles and a fourth one is being installed, each having a capacity of 20 tons. The kettles are heated by steam coils. Flux oil is delivered from tank barges to a storage tank on shore by a 6-in. pipe line. The asphaltic cement is discharged from the melting tanks through steam jacketed pipes with quick-opening valves into weighing buckets on a trolley, which receive the charges from any kettle and deliver to either mixer. The sand and stone are weighed by a portable beam scale. A third bin is provided for the storage of cement or stone dust. At the bottom of the bin is a spiral conveyor operated by a hand lever which discharges as much filler as is necessary directly into the weighing boxes.

Sand, stone and cement are dropped from the weighing boxes into Iroquois mixers of 16 cu. ft. capacity each, being provided with manganese steel blades. The mixers are steam jacketed and are located above the floor in order that they may discharge directly into trucks. There are three rotary drum driers, 24 ft. long, 5½ ft. in diameter, two being for sand and one for stone. Each drier can dry and heat 15 tons of stone an hour to a temperature of 400 deg. Fahr. Gases and dust from the driers pass through a dust collector. Temperatures of sand, stone and asphaltic cement are registered on automatic recording instruments placed in the office.

ORGANIZATION

Seven asphalt gangs and one concrete gang were working steadily after operation had been well organized. The superintendent, who reports to the chief engineer, directs the work of a plant supervisor, a gang supervisor, office force and a chemist. Each asphalt gang consists of one foreman at $4.50 a day; one asphalt steam roller engineer at $5; three watchmen at $600 a year each; two rakers at $3; two tampers at $2.80; two smoothers at $2.50; one roller boy at $2.50; and seven laborers at $2.50. The minimum wage of $2.50 a day is in accordance with a resolution of the Board of Estimate and Apportionment.

COST

The specifications under which asphalt pavements were laid in Manhattan Borough call for 3 in. of asphalt after compression. Needless to say when repairs are made it is not necessary to replace 3 in. compressed, but that 2 in. compressed is a close approximation. In comparing costs with former contract prices, however, the only basis upon which costs should be figured, according to Mr. Durham, is by the square yard, and so in the following this has been borne in mind. The following unit material costs show what was paid during the year: Portland cement, $8.07 per ton, less 10 cents for bag rebate; asphaltic cement at $14.45 per ton; crushed stone at $1.10 per cubic yard; sand at 80 cents per cubic yard.

The original cost of the plant, including equipment and tools, was $153,000. The interest on the investment figured at 4 per cent for seven months is $3570. The rental, calculated at 4 per cent of the value for seven months, is $3733. Depreciation, amounting to 10 per cent per year for seven months, is $8925. Fuel and lubricants cost $3830.29. Superintendence cost $3898.79. The grand total of these items is $23,957.08.

PLANT PRODUCTION

The plant produced 143,086 cu. ft. of wearing surface mixture and 116,910 cu. ft. of binder mixture, making a total of 259,996 cu. ft. With this material 129,876.8 sq. yd. of pavement were repaired, of which over 6000 sq. yd. was on cuts. The total yardage laid gives an overhead and depreciation charge per square yard of 18.4 cents. The total plant output gives an overhead and depreciation charge per cubic foot of 9.2 cents. The accompanying tables give a summary of the costs.

COST OF OPERATION AND WORK DONE BY MUNICIPAL ASPHALT PLANT IN 1914

	Maintenance work	Restoring openings, including foundation	Total
Plant labor	$12,909.91	$2,382.84	$15,292.75
Street labor	40,528.47	7,148.53	47,677.00
Transportation	16,356.70	2,767.30	19,124.00
Materials	30,613.83	5,158.29	35,772.12
Total	$100,408.91	$17,456,96	$117,865.87
Sq. yd. laid	123,253	6,623.8	129,876.8
Av. cost, sq. yd.	$0.814	$2.630	$0.906
Ov'hd. and deprec.	0.184	0.184	0.184
Total cost, sq. yd.	$0.998	$2.814	$1.090
Total cost, cu. ft.	0.506	0.506	0.506

PLANT LABOR COST

Foreman, 14 days at $4.50	$63.00
Stationary engineer, 315 days at $4.50	1,417.00
Machinist, 170 days at $5.00	850.00
Hoist engineer, 137 days at $4.75	2,814.00
Fireman, 938 days at $3.00	2,814.00
Asphalt workers, 3799 days at $2.50	9,497.50
Total	$15,292.75

STREET LABOR COST

Foreman, 996 days at $4.50	$4,482.00
Steam roller engineer, 950 days at $4.75	4,512.50
Asphalt workers, 15,473 days at $2.50	38,682.50
Total	$47,677.00

TRANSPORTATION COST

Vehicle, 2 horses and driver, 2732 days at $7.00	$19,124.00

COST OF MATERIALS

Sand, 8322 cu. ft. at $0.80	$6,657.60
Stone, 4547 cu. yd. at $1.05	4,774.35
Portland cement, 1223 tons at $8.07, less bags	7,369.61
Asphalt cement, 1172 tons at $14.48	16,970.56
Total	$35,772.12

In 1914 the average price of asphalt repair work was $1.47 per square yard, the per cent relaid 4, and the cost per square yard of maintained area $0.055. With the municipal plant these figures were: $0.998 per square yard for repairs, 4 per cent relaid and $0.04 for the cost per square yard of the area maintained. There were under maintenance 3,061,749 sq. yd. of which contract repairs amounted to 114,793 sq. yd. and by the plant 123,253 sq. yd.

Underwriters and Fire Protection Association Report on Edison Fire

Behavior of Concrete Is Fully Discussed; Chief Blame Is Laid on Lack of Measures to Prevent Spread of Fire

As was to be expected, chief blame for the fire disaster at the plant of Thomas A. Edison, Inc., at West Orange, N. J., Dec. 9, is laid in the report, just made jointly by the National Board of Fire Underwriters and the National Fire Protection Association, to the lack of adequate protective measures, such as a sufficient water supply system, automatic sprinklers, fire resistive window and door construction, and fire walls. In regard to the concrete buildings, the authors of the report find much to be learned from the fire, particularly as to the effects of expansion. Their attitude, in sum, is given in the following paragraph, found in the conclusions:

"Confidence in the reliability of reinforced concrete as a fire-resistive construction should not be destroyed because of this disaster. Many such buildings have been erected which would undoubtedly meet such a test more satisfactorily. It must be remembered that all the various types of fire-resistive construction have at some time during the period of their development met with similar disaster, and the lessons learned thereby have served to correct defects."

Those participating in the preparation of the report were F. J. T. Stewart, chairman of the executive committee of the National Fire Protection Association; Ira H. Woolson, consulting engineer of the National Board of Fire Underwriters, who contributed the part on the reinforced-concrete construction and assisted with the remainder of the report; Charles H. Fischer, superintendent of the engineering department of the Office of Schedule Rating Expert of New Jersey, and G. Y. Lancaster, Jr., engineer of the New York Board of Fire Underwriters.

With respect to the general conditions, apart from the effects of the fire on the reinforced concrete buildings, the report sums up the lessons as follows:

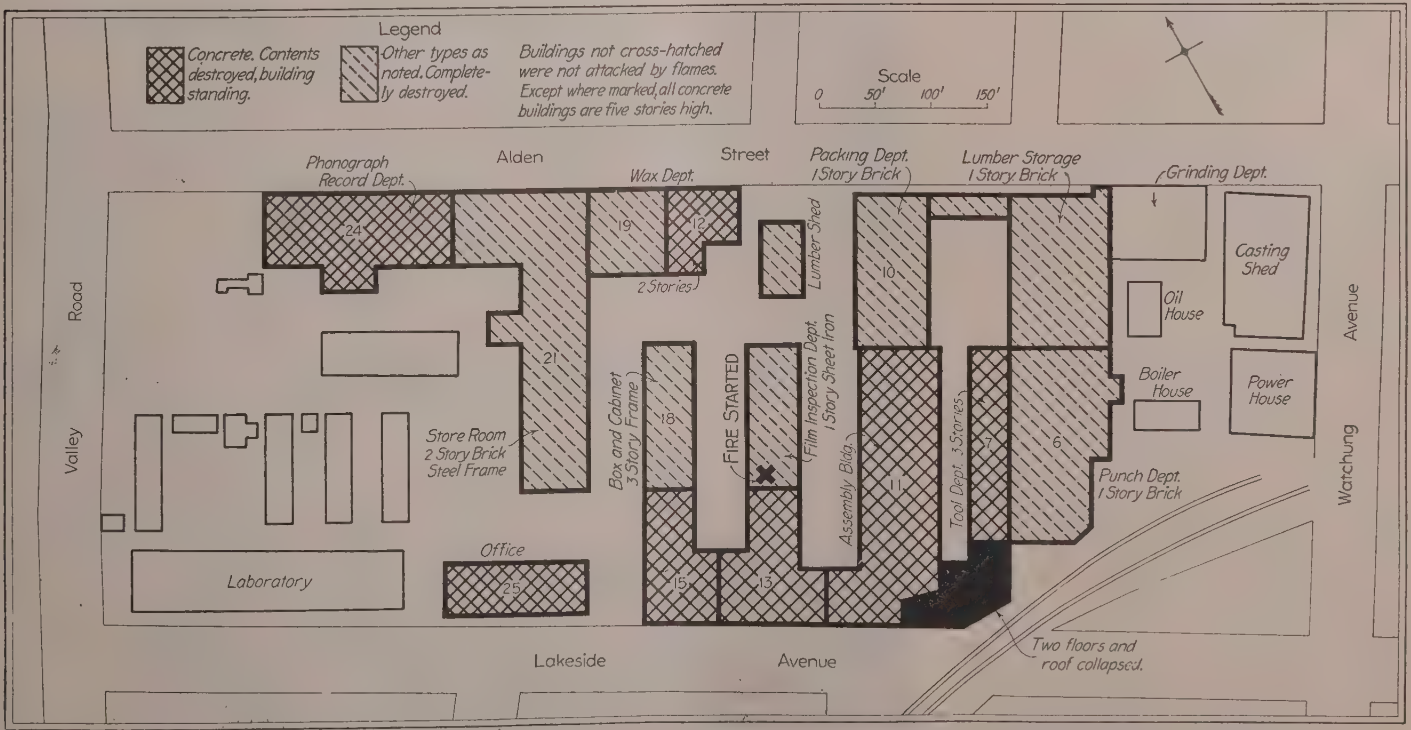
FIRE DIVISIONS

1. That reliable fire stops in the form of standard fire walls separating adjoining buildings or sub-dividing large individual buildings, and approved fire shutters or fire windows for exterior openings, are essential to preserve the integrity of large plants against the spread of fire; that reliable fire stops for all floor openings are necessary to protect individual buildings against the upward spread of fire; that the protection of exterior windows is also important in restricting the vertical spread of fire, as well as resisting exposures from adjacent buildings.

The details of this report strikingly illustrate the fact that adjoining and communicating buildings without proper fire stops were general throughout; that one group of buildings consisting partly of reinforced-concrete construction and partly of light brick and frame structures aggregating a floor area of 103,750 sq. ft. was without fire stops; that the absence of window protection was general; that the protection of floor openings was attempted, but was not the equivalent of present standard practice which requires a masonry enclosure at least 8 in. thick with standard fire doors at openings to each story.

GYPSUM BLOCK PARTITIONS

2. That the test afforded of 3-in. cinder gypsum block partitions was of value only as indicating their suitability for the construction of room partitions. To this extent, the gypsum blocks made a good show-


Legend
▩ Concrete. Contents destroyed, building standing.
▧ Other types as noted. Completely destroyed.
Buildings not cross-hatched were not attacked by flames. Except where marked, all concrete buildings are five stories high.
Scale
0 50' 100' 150'
Alden Street
Phonograph Record Dept.
Wax Dept.
Packing Dept. 1 Story Brick
Lumber Storage 1 Story Brick
Grinding Dept.
Casting Shed
Oil House
Boiler House
Power House
Watchung Avenue
Valley Road
Lumber Shed
24
19
12
10
2 Stories
21
Store Room 2 Story Brick Steel Frame
Box and Cabinet 3 Story Frame
18
FIRE STARTED
Film Inspection Dept. 1 Story Sheet Iron
Assembly Bldg.
11
Tool Dept. 3 Stories
7
6
Punch Dept. 1 Story Brick
Laboratory
Office
25
15
13
Lakeside Avenue
Two floors and roof collapsed.

PLAN OF EDISON FACTORY, WEST ORANGE, N. J.—BUILDINGS CROSS-HATCHED ARE THOSE DAMAGED BY FIRE ing. They were thoroughly calcined, of course, and had lost most of their strength where exposed to severe heat, but a considerable number remained in place. Others were knocked down by the collapse of window and door frames or other shocks. One-half-inch twisted stiffening bars made necessary in the stories with high ceilings seem to have assisted appreciably in keeping the partitions in position.

That the reliability of gypsum blocks as a protection around floor openings and for similar purposes cannot be judged from this fire, as the blocks were not of a suitable thickness and were not used in connection with standard fire doors.

HAZARDOUS PROCESSES

3. That nitro-cellulose motion picture films are of such a hazardous nature that they should be stored and handled only at isolated locations. Only a limited number of these films should be exposed in process in any one room, and such rooms should be separately inclosed by fireproof partitions with approved fire doors. Automatic sprinklers should invariably be installed at such locations, even if the main part of the plant is not so equipped.

4. That the handling of inflammable materials, introducing a special fire hazard, should invariably be segregated, preferably by complete isolation, in buildings as small as the necessities will permit; when necessarily of considerable area they should be sub-divided by fire walls.

The storage and handling of nitro-cellulose picture films at various locations in the largest group of buildings, together with the storage and handling of wax and similar materials in the group of buildings comprising No. 24, are striking examples of the necessity for the segregation of such processes.

FRAME BUILDINGS AND ROOF COVERINGS

5. That the location of large area frame and similarly combustible buildings with inflammable contents, in the center of a plant or group of buildings constitutes a serious conflagration hazard, jeopardizing the entire plant.

6. That incombustible roof coverings are essential to reduce the conflagration hazard.

FIRE PROTECTION

7. That a complete system of automatic sprinklers is a prime necessity in any large plant having combustible contents, regardless of the character of the construction.

This is generally true, but especially so for plants located in small towns and villages which have very limited fire protection facilities not designed nor expected to cope successfully with problems of such magnitude.

8. That the water supply for automatic sprinklers should not be subject to impairment by connections with hydrant mains and standpipes without proper control valves.

9. That next in importance to automatic sprinklers is a complete system of inside and outside hydrants on separate and distinct mains from the house service lines, with a supply of water which will be adequate and reliable at all times. In conjunction with such a system, a well organized thoroughly drilled and properly equipped private fire brigade should be maintained. Full dependence cannot be placed even upon such a fire brigade; it will ordinarily be reliable, however, to supplement a complete system of automatic sprinklers.

10. That the owners of large plants especially when locating in small towns or villages should give careful study to the subjects both of public and private fire protection.

TEMPERATURES DEVELOPED; FUSED CONCRETE

The positions of the report referring to the temperatures developed and the fusing of the concrete are reproduced below practically in full, but the discussion of the damage to the concrete buildings is so lengthy that the detailed description of the injury to each building is omitted. The general discussion on the damage, however, is given verbatim:

The heat attained in this fire was exceptionally high and continued from one to three hours, owing to the quantity of inflammable materials and lack of water. Evidence of temperatures ranging from 2000 to 2500 deg. Fahr., and probably higher, was found in many places.

There were evidences of fused concrete on parts of columns, beams and floor slabs in basement of the Wax House, No. 12. Several beams and floor slabs appeared to have wasted away as a result of this fusion. Slag has flowed down the side of the columns and hangs in stalactites from the bottom of the beams and floor slabs. This would indicate a temperature of 2500 deg. Fahr. or more at this location. Reinforcing bars were also found melted where exposed by the fusing of the concrete in the beams and floor slabs. There was also a limited quantity of slag and other evidence of fused concrete in the west end of the third story of No. 24, near the failed columns where heat from the burning wax was most intense. Similar evidence was found in the vicinity of the general collapse in No. 11.

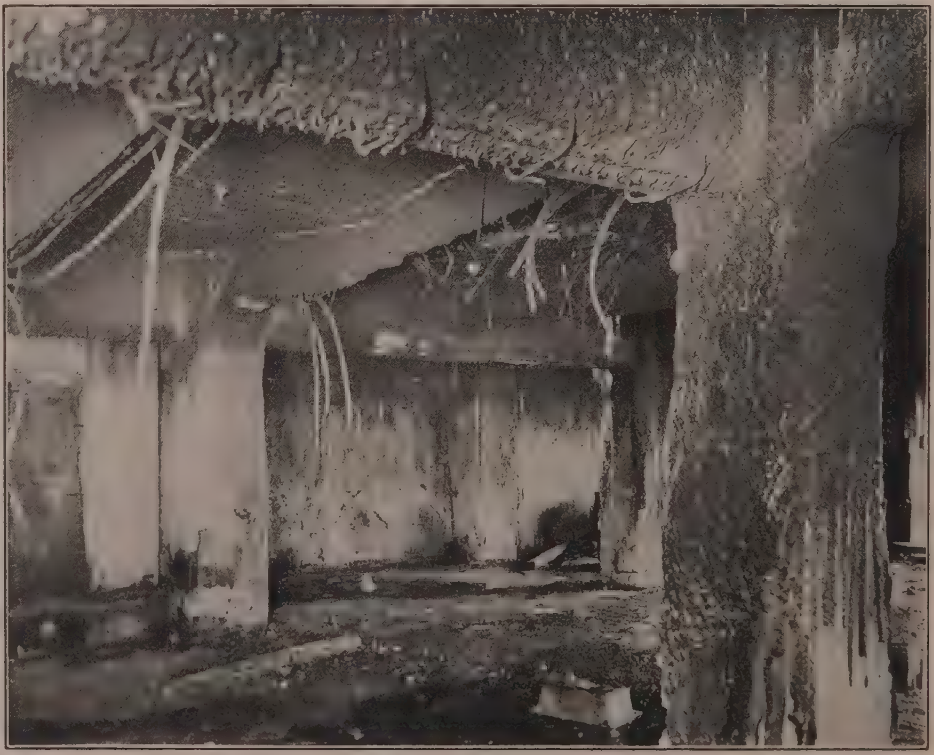
A careful investigation of this slagged concrete, and the fusibility of concrete in general, is being made by the U. S. Bureau of Standards. The results thus far obtained indicate that the formation of the concrete slag was due in part at least to intense heat. The investigation is not yet completed. It is, of course, possible that highly heated chemicals may have contributed to the excessive destruction found in No. 12. However, the fact remains that well defined samples of fused concrete were found in two other buildings, and it is hardly probable that the same chemical agencies would have induced the fusing in those cases.

Large pieces of steel and cast iron melted in a number of places, notably in Nos. 7, 11, 12, 15, 18 and 24. Melted copper and brass were commonly found and glass, of course, melted freely almost everywhere.

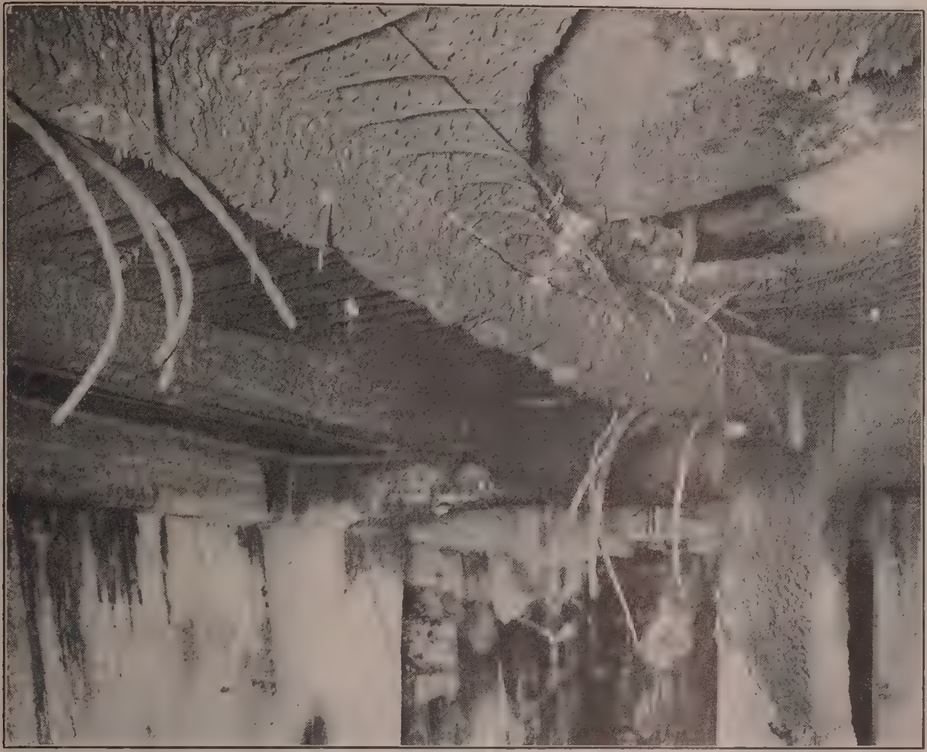
DAMAGE TO CONCRETE BUILDINGS

In contrast to the ordinary buildings, the effect of the fire on the concrete buildings is of exceptional interest. In considering the resistance of the concrete structures to this fire, it is notable that in several cases two or more stories were held rigidly in position by their attachment to the surrounding structure, after a line of three to five wall columns below them had collapsed; thus testifying to the remarkable integral strength of the buildings. Concrete panel walls withstood the fire excellently. There was no case of individual collapse of a floor slab, beam or girder except in the basement of No. 12, where concrete and reinforcement were apparently melted away, causing failure of three beams and a floor slab, as shown in views herewith.

All other failures including the complete collapse of a portion of building No. 11, must be attributed to the columns. It is true that there were beams showing bad cracks, but these in the majority of cases seem to have been due to the failure of columns in the vicinity. Deflection of beams was very general in those locations subjected to the most intense heat, notably in the first floor of No. 11, basement of No. 12, all floors of No. 7, third and fourth floors of No. 15, and the third floor of No. 24. How much of this deflection existed in beams before the fire, due to premature removal of forms at the time of construction, is of course unknown. As the spans



DAMAGE IN BUILDING 12, ATTRIBUTED IN REPORT TO FUSION OF CONCRETE



CLOSE VIEW OF DAMAGE IN BUILDING 12, ATTRIBUTED TO FUSION

were considerable, it is quite possible there may have been some initial deflection. Where beams are deflected, vertical cracks appear in the lower part of the beams at frequent intervals as might be expected, when the steel elongated under the influence of heat. It is probable that such deformed floor construction has lost a considerable portion of its carrying capacity. In very few places has the concrete under the reinforcement of the beams broken off. For instance on the third floor of No. 24, where the beams were deflected badly, only five out of ninety-three interior beams had the concrete broken off, or 5.4 per cent. About 5 per cent seems to be general for all locations where the heat was most intense. The extent to which the beams deflected would seem to indicate that the fireproofing provided—1 in. of concrete at the sides and 2 in. at the bottom of the beams—was not sufficient for proper heat insulation. The floor slabs have scarcely spalled at all and show very little sagging or pocketing between the beams except in Building 7.

COLUMNS

The action of the columns was not as satisfactory as that of the other concrete members. All columns, except in No. 7, were square and reinforced by twisted bars located at the four corners 2 to 4 in. from the surface. In the lower stories additional bars were located at the middle of the sides on a line with the corner bars.

What seems to have happened when the columns were subjected to fire was this: The sudden and intense heat produced rapid expansion of the surface concrete, resulting in severe internal stresses. The expanding concrete near the surfaces of the column at right angles to each other, subjected each corner to stresses from two directions tending to force the corner off in the line of the diagonal. At the same time the surface concrete, especially at the corners where heated on two faces, tended to expand lengthwise and thereby assume an undue proportion of the column load, with the result that shearing stresses were produced between the highly heated corners and the colder interior portions of the column. This action occasioned a buckling effect on the corners, and a cracking of the concrete at right angles to the length of the column.

The combination of all these forces produced tensile and shearing stresses in diagonal planes across the corners, which resulted in splitting them off lengthwise from most of the columns. This action is illustrated by a diagram herewith.

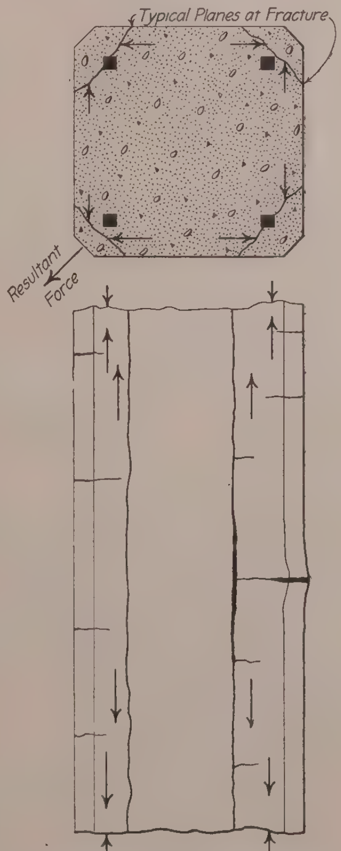
The corner reinforcement bars also tended to produce a plane of weakness in the concrete; many of the corners splitting off along the line of these bars. In some cases the bars may have expanded sufficiently to have aided the splitting action, but the indications are that most of these corner failures originally occurred outside of the bars, at a point where the stresses more than equalled the tensile strength of the concrete in the diagonal plane of fracture. In many cases it was noted that pieces of stone in the planes of fracture were split, thus showing that the concrete was good, and had developed its full tensile strength. With the corners removed, the reinforcing bars had little protection from the heat, consequently expanded rapidly, forcing themselves out of the columns, and carrying with them any attached surface concrete.

The theory advanced by some investigators, that the steel bars due to their expansion were responsible for the original fractures of the corners, we think improbable. The coefficient of expansion of the concrete is approximately the same as for steel, and as all the heat reaching the steel bars would have to pass through the concrete covering, it is probable that the former would always be a little cooler than the latter. This assumption is strengthened by the fact that one side of each bar was in contact with the cool interior concrete. Furthermore the thermal conductivity of concrete is low (see Investigation of Thermal Conductivity of Different Concrete Mixtures, "Proceedings," American Society for Testing Materials, Vol. VII, 1907, page 404), and it is known that a point 2 to 4 in. beneath a concrete surface subjected to a heat of 1700 deg. Fahr. for two hours, will only attain a temperature of 400 to 500 deg. It must also be remembered that a large portion of the bar surface in these columns was protected by considerably more than 3 in. of concrete. The numerous instances where the corners split off and the bars were not exposed, is evidence in support of this theory. While hose streams may have contributed to the failure of some of the exterior columns, the probabilities are that they produced little if any effect upon the disintegration of the interior columns. Reports of the fire generally substantiate the statement that the majority of the interior columns were never touched by water.

PROBABLE EFFECT OF TIES

In spite of the disintegration of the surface concrete, it is probable that if the bars had been properly tied, many of them would have stayed in place and the column injuries would have been less severe. There were only three failures of interior columns; one of these was on the third floor of No. 24 where the heat was intense, another on the third floor of No. 11 near the collapsed section, and the other under the collapsed section of No. 11. The latter was undoubtedly caused by the shock of the falling floors above; whether the former was influenced by the collapse of the adjacent wall columns, is uncertain.

The action of the disruptive forces described, produced similar separation of the surface concrete on the sides of many columns, but generally the concrete remained in place and the injury was not apparent



SUGGESTION AS TO FORCES WHICH BROKE OFF COLUMN CORNERS until the columns were stripped for repairs. These cleavage cracks were usually 1 to 2 in. in from the surface. In numerous cases, columns are spalled to 60 per cent of their original size, and are still bearing their load without apparent deflection.

Wall Columns

Complete collapse of wall columns in sets of three to five occurred in the first story of Building 11, and the third story of Buildings 15 and 24. In all cases the columns were subjected to intense heat, the first being the Shipping Room, which contained a mezzanine floor and the whole story filled with very combustible material; the second was a cabinet shop; and the latter the story in which 20 tons of wax records are reported to have been stored near the point where the columns failed.

The greater injury to the wall columns is believed to be due to two causes. First, to the fact that while subjected to intense heat on the room side, the opposite side exposed to the outer air was kept comparatively cool, and was in some cases subjected to cold water from hose streams; second, owing to the columns being held rigidly in position vertically from the floor to the top of the panel walls, they were less able to resist the expansion of the building as a whole, which naturally resulted from the attack of fire. It is probable that the four ¾-in. untied bars which were used to reinforce the wall columns, were not of much service in resisting the shearing stresses, particularly after the protecting concrete had spalled off and the bars had become hot. The interior columns being free from floor to ceiling were more flexible and better adapted to resist the bending moments due to this expansion.

Corner Columns

In each case of collapsed wall columns, failure occurred adjacent to, but not including a corner column; the latter remaining in good condition, except two which had through cracks at the floor level. This was probably due to the fact that they were more heavily reinforced, and that they were free to bend from floor to ceiling in the direction in which the building expanded. This theory of the bending of the columns due to the expansion of the building is further substantiated by the existence in all cases of a V-shaped crack between the corner column and the adjacent wall panel, starting at the floor and widening upward. In some cases the top of the crack is open an inch. It is presumable that when the column moved away from the panel, bits of debris fell into the crack which prevented it from completely closing when contraction took place. Further evidence in support of the theory is furnished by the observation that all the columns in each set failed by diagonal shear in the same direction.

It is notable that in all the wall column failures, the corner column, assisted by the cantilever action of the floor system over the interior columns, carried the stories above without collapse, except that which occurred in the upper stories of Building 11. This happened at an angle in the long side of the building; the column at the angle was braced on each side by panel walls, and therefore could not bend in the line of expansion thrust to the eastward as freely as a corner column. This may have contributed to its failure and those beyond it on the other side of the angle. This portion of the building was also carrying concentrated floor loads in the form of heavy machinery and plating tanks of large capacity. When the columns in this section, both interior and exterior, began to spall, and the reinforcement was forced out by expansion, they probably were considerably weakened, and were no longer able to support the heavy loads imposed upon them plus the expansion stresses.

How far the irregular distribution of reinforcement bars may have contributed to columns failures, is problematical. It is reasonable to assume that such irregularities would not be likely to increase their stability.

All collapsed columns show characteristic diagonal shear fractures. In most cases the reinforcing rods offered no resistance to this action as their bond of concrete had spalled away.

Collapse in Building 11

A complete collapse of the upper three stories occurred at the east end of No. 11. Adjoining this wing on the north was Building 7, the third story of which constituted the film department; the film storage and inspection was conducted in the second story of No. 11. The occupancy enumerated for these stories would not indicate combustible material enough to account for the collapse of the building; nor is it certain that upper floor loads exceeded the 200 lb. for which they were designed. The film storage building does not seem to have contributed the heat, for the columns on that side are still standing to the roof of that building. A suggestion that acids in the plating department may have weakened the concrete could not be substantiated.

The following report of this collapse by an eye witness, is interesting as indicating the progression of the failure eastward from the middle portion of the building as would be expected if produced by expansion stresses. The observer stood upon the opposite side of Lakeside Avenue directly opposite the collapsed portion.

"At the time these observations were made the fire was burning brightly on the third floor. At 7.40 p. m. wall column 15 on the third floor started spalling near the ceiling. This was followed by a shear crack about 30 in. long. Then column 16 began to spall and shortly after sheared in a similar manner. In the meantime the shear of column 15 widened and the upper part began to shift or slide down the sheared surface. Then columns 17 and 18 spalled and sheared in the same way; in each case after some 5 to 8 min. the openings became larger. When column 19 failed in like manner, the first collapse occurred and involved the panels to the rear of the columns just mentioned. This happened at 8.10 p. m. about a half hour after the first column started to shear. The second collapse occurred about 8.40 p. m., and brought down the section at the east of the first failure, and adjoining Building 7. This collapse took place without apparently having been caused by the impact or falling of heavy contents, nor was there any phenomena such as an explosion accompanying it."

Round Columns

The round columns in No. 7 appear to have suffered only minor damage. It will be necessary to remove the sheet metal casing to ascertain whether the concrete cores have been injured. The indications are that the heat to which they were subjected was somewhat less than that which prevailed in some areas where the badly injured square columns were located. Nevertheless, the apparently efficient protection afforded the concrete by the metal lath and plaster covering, is a matter worthy of careful future investigation.

In practically every case where square columns were subjected to intense heat they spalled at the corners and tended to assume an octagonal or circular shape. This behavior clearly indicates the weakness of the square column when attacked by fire. If well designed round, hooped columns had been used, it is probable that the results would have been quite different. The behavior of the round columns in Building 7 strongly supports this opinion. Well known engineers have advocated the round type of reinforced-concrete column for some years, basing arguments mainly upon structural efficiency; but this disaster accumulates evidence of the unfitness of the square column to resist a severe fire.

In order that this discussion of the damaged columns shall not obscure the fact that throughout the plant more columns were intact than were seriously injured, a table has been prepared showing the actual number of injured and failed columns on each floor in comparison with the total number, in Buildings 11, 13, 15 and 24.

Summary

While these various theories and descriptions may explain what actually happened in the sequence of events preceding the failure of different structural parts of these buildings, they do not justify the general conditions which produced the results which confront us, and unless the experience thus gained will insure that future specifications shall be drafted to prevent a repetition of such a disaster under similar conditions, it will indicate that either the lesson has not been properly learned, or that the design and construction of these buildings are not suited for the purpose employed. Whether any other system of construction would have given better results under the same conditions, is problematical. The lesson is being carefully studied by many competent persons. The knowledge gained will doubtless aid in eliminating unwise practices in reinforced-concrete construction. It has needed an expensive lesson of this kind to demonstrate the strict necessity for changes in design, and methods of construction to meet such conditions. Reinforced-concrete buildings can doubtlessly be built which would withstand such a fire satisfactorily, but no type of construction should be left to meet such an attack without the assistance of any of the standard fire-resistive measures which should be a part of every first class building.

Valuation Exceeds Capitalization on the railroads in three of the four States in which appraisals have been made in the last ten years and virtually equals it in the fourth, according to statistics presented by Howard Elliott, president of the New York, New Haven & Hartford Railroad, in a recent address to the Alumni Association of the Massachusetts Institute of Technology. The four States are Washington, South Dakota, Minnesota and Wisconsin. The total valuation and capitalization figures in the four States are respectively $958,316,613 and $796,054,270, indicating an excess value over capitalization of 20 per cent.

Literature

For the Civil Engineer and Contractor

New Publications

Report of the Joint Committee on Federal Aid in the Construction of Post Roads. Paper, 6 x 9 in.; 317 pages, inserted folded tables. Washington, D. C., Superintendent of Documents.

National Association of Cement Users; Proceedings of the Eighth Annual Convention, March 11-16, 1912. Volume VIII. Cloth; 6 x 9 in.; 819 pages; illustrated. Philadelphia. The American Concrete Institute.

Rivers and Lakes Commission of Illinois. Annual Report, 1913-1914. Cloth; 6 x 9 in.; 60 pages; illustrated. Chicago, Rivers and Lakes Commission.

Report of Committee on Statistics of Water Purification. New England Waterworks Association. Paper; 6 x 9 in.; 24 pages. Boston, New England Waterworks Association.

Measuring Devices Used in the Delivery of Irrigation Water. Agricultural Experimental Station, Berkeley, Cal., Bulletin 247. Paper; 6 x 9 in.; 180 pages; illustrated. Berkeley, Cal., Agricultural Experimental Station.

New York State Commission of Highways. Report for the year ended Dec. 31, 1914. Paper; 6 x 9 in.; 53 pages. Albany, N. Y. State Commission of Highways.

Board of Water Engineers for the State of Texas. First Report Covering the Period from Sept. 1, 1913, to Aug. 31, 1914. Paper; 6 x 9 in.; 47 pages; 1 map. Austin, Texas, Board of Water Engineers.

Books Reviewed

Use of Water in Irrigation

Author, Samuel Fortier, D. Sc., Chief of Irrigation Investigations, Office of Experiment Stations, U. S. Department of Agriculture. Cloth, 8 x 5½ in..; 265 pages; 71 illustrations. New York, McGraw-Hill Book Company, Inc. $2 net.

Reviewed by F. W. Hanna

Supervising Engineer, U. S. Reclamation Service.

In a book on the use of water in irrigation written by Samuel Fortier after his long years of experience in field and office irrigation work, one expects to find much practical and useful information; and a careful reading of this book verifies this expectancy. At the risk of repetition the author has drawn somewhat on the recorded experiences of his technically trained coworkers in the Government service. As a result his book smacks some of Government bulletins, but this will be more of advantage than of disadvantage to the general reader.

The book treats of the use of irrigation water after it reaches the farm. It is, therefore, essentially a book for irrigation farmers, actual and prospective, and for elementary students of agriculture and engineering who expect to deal with irrigation farming.

The author, after devoting one general chapter to the introduction of his subject, starts at its foundation by devoting a strong and helpful chapter to the discussion of methods of acquiring an irrigated farm and the right to water to irrigate it, and the relation of the water to the soil. Following this is a chapter on the necessary equipment to handle an irrigated farm and the requisite structures for getting the water over the land. Chapter four deals with clearing and leveling the land and various methods in use of spreading the water over it as modified by topography, soil and crops. The next chapter discusses the delivery and measurement of water to the farm, the duty of water in growing crops and the waste of water on the farm through evaporation, seepage and other causes. The final chapter of the book presents interesting and valuable information on the soils best adapted to particular crops and how to handle them, the methods of irrigation best suited to the crops and the amount of water required for their growth. For many farmers this will be found to be the best chapter of the book.

Although somewhat elementary in character, the book is written in a semi-scientific spirit, with substantial reasons stated for most of the conclusions. The style is simple and the English good; the subject is logically developed, though briefly treated; the book is neatly bound and attractive. It should find a wide field of use among irrigation farmers, for whom it is written.

Oregon Highway Report

First annual report of Oregon State Highway Engineer. Contains 240 pages and 45 folder plates.

This report covers all phases of the highway work in Oregon accomplished in the eighteen-month period prior to Nov. 30, 1914. It gives a detailed account of each separate piece of work with itemized cost, and includes sample specifications, nine pages of instructions to locating engineers and a list of the salaries and titles of 155 employees, as well as much general information bearing on various types of road work.

A notable feature of the report is the analysis it makes of the cost of highway bridges in Oregon. Seventeen pages are devoted to this subject and it is pointed out that the county courts, under whose jurisdiction comes the awarding of county highway bridge contracts, are practically helpless in the hands of the average bridge company. It is recommended that all highway bridge work be put in the hands of the State highway commission hereafter. One of the reasons given for the excessive cost of the county highway bridges, in addition to the lack of unbiased technical advice, is the formation of "pools" among builders. Instances are cited in which the contractor made a profit of more than 100 per cent on the steel alone.

Under the head of "Investigation of Recent Bridge Construction" is given the itemized cost to the county of all recently constructed steel and concrete bridges, and this is compared with a similarly itemized estimate of what is considered a reasonable cost. Considerable space is given to the right-of-way department, and an explanation is made of the methods by which nearly all of the 60-ft. right of way was obtained gratis.

Concrete Pile Standards

Author, Hunley Abbott, Vice-President and Chief Engineer of the MacArthur Concrete Pile & Foundation Company. Paper; 9 x 12 in.; 59 pages; illustrated. New York City, 11 Pine Street, Hunley Abbott.

This publication is divided into five chapters—standard details for pile caps, standard specifications for concrete piles, concrete versus wooden piles (a comparison of costs), methods of testing concrete piles, and how a pile supports its load.

Drawings show the arrangement and spacing of piles and the design and reinforcement of pile caps for pile clusters of from one to twenty-five piles under the assumption that each pile takes a load of 30 tons. A table gives the thickness of cap required if the permissible load per pile is 35 tons. The placing of piles under walls and wall columns is then described and shown in three full-page drawings followed by a table giving dimensions and reinforcement of continuous pile caps for column footings along building lines.

In the chapter dealing with standard specifications for concrete piles special clauses refer to pedestal piles, Raymond piles, Simplex piles, and pre-moulded piles. The comparison between concrete and wooden piles is, of course, favorable to the former and should not be taken at its face value. The case used as an illustrating example proves beyond doubt that concrete piles were better and more economical than wooden piles in that instance, but such is not always the case. Combination piles, where wood is used below the ground-water surface and concrete above it have not been mentioned, although that type has advantages over certain types of concrete piles, especially those consisting of a straight shaft only and when used as friction piling.

The last chapter in the book, "How a Pile Supports Its Load", treats only the case where the load is vertical. The book ends with a table of safe bearing power of soils as given by Prof. Ira O. Baker in his book "Masonry".

Structural Design, Volume II—Design of Simple Structures

Author, Horace R. Thayer, Assistant Professor of Structural Design, Carnegie Institute of Technology. Cloth, 6 x 9 in.; 495 pages; 160 illustrations. New York, D. Van Nostrand Company. $4.

Reviewed by F. H. Constant

Professor of Civil Engineering, Princeton University.

Volume I of the trilogy on "Structural Design," by this author, was reviewed in Engineering Record of Sept. 27, 1913, page 363. It is largely descriptive and is concerned with methods of fabrication of steel structures and the elements of design. The present volume is somewhat larger and has to do almost wholly with design. Its scope is indicated by the chapter headings as follows, the numbering of articles and chapters being continuous with that of Volume I: "Beam Bridges—Plate Girders", "Steel Viaducts and Elevated Railways", "Simple Riveted Truss Bridges", "Simple Pin-Connected Bridges", "Steel Mill Buildings", "High Office Buildings", "Miscellaneous Building Work," theaters, grandstands, railway stations and mine structures, and "Standpipes and Elevated Tanks." As in the first volume, the work presupposes a knowledge of mechanics and stresses. Frequent reference to Volume I, especially for the specifications, virtually assumes an acquaintance with that section.

The production of the new volume has required a great amount of painstaking labor, and its appearance in the field of practical design will, owing to the constant progress continually made in this art, be viewed with interest by engineers and teachers. The book contains nothing new for the experienced engineer. It is intended primarily to give the student a general survey of a rather broad field of structural designing. In a field which has developed such an enormous amount of technic and searching analysis, where good-sized volumes have been written on singles phases of the subject, such as plate girders, mill building and secondary stresses, to try to show everything in a work of moderate size is a very difficult task. The value of the book for the beginner will depend on the nature and amount of supplementary instruction which may be given him, or on previous experience in designing which he may have had. Otherwise he will find the rather abbreviated and hurried style and the insufficiently explained derivations and computations hard reading. Perhaps there is need for a general book like the present on structural designing. There is still need for the more exhaustive treatises on the individual aspects of the subject which will bring out clearly all of the present-day scientific methods of analysis and design in each field.

The book is open to criticism in several respects. There are a number of errors in text, computations and theory. Weights of the different types of structures and economical dimensions are computed from rather elaborate formulæ, which are painstakingly rationally derived, but whose use is conditioned in so many ways as to make them of doubtful utility. A few tables of actual shipping weights would be of far more value to the practical designer. Articles 94 and 109 give interesting methods for determining deflections of plate girders and secondary stresses in truss bridges. The reviewer questions, however, the wisdom of an inadequate treatment of such difficult subjects in an elementary treatise of this character. They might better have been reserved for Volume III, on the "Design of Advanced Structures."

The book is largely descriptive. Methods of computation and details of design are illustrated by practical examples of each of the principal types of structures with accompanying specifications. Lists for reference reading, scattered throughout the book, furnish sufficient collateral study for the industrious student to give him a clear understanding of the subject. The book is well illustrated and contains a number of tables giving the leading dimensions of many actual bridges of the several types.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Economic Design of Concrete Slabs

Sir: I beg to call your attention to an error—obviously typographical—appearing in J. Norman Jensen's article "Economic Design of Concrete Slabs", in the Engineering Record of Feb. 6, page 170. The formula for the constant K is written with the denominator $6(f_c + nf_c)^2$, which should be $6(f_s + nf_c)^2$.

Baltimore. W. Howard Cordrey.

Microsopic Study of Concrete

Sir: I beg to call your attention to a typographical error in the summary of the first article of my series on concretes, in your issue of Jan. 23, page 102. As printed the first clause of paragraph 7 reads as follows: "That the pieces of large aggregate and the particles of small aggregate in a concrete are in direct ratio one to another, at distances approximately equally great, relative to their size."

This should have read: "That the pieces of large aggregate and the particles of small aggregate in a concrete are widely separated, one from another to distances approximately great, relative to their size."

Nathan C. Johnson,
Engineer of Tests, Raymond Concrete Pile Company, New York City.

A National "Factor of Safety"

Sir: "A National 'Factor of Safety,'" by William R. King, in your issue of Jan. 30, 1915, page 133, is very interesting, as is the editorial "A Call to Duty," on page 127 of the same issue.

Having responded to "A Call to Duty" in '98 as a private, I am in a position to realize how fortunate was the United States that year to be fighting an inferior foe. When we made the charge at El Caney, modern defenders would have wiped out of existence the three companies of the Twelfth Infantry before they had got halfway up the hill.

The opponents of any National "factor of safety," in order to be consistent, should pledge themselves to be among the first to take the field in case of war. The only plan of defense they have to offer is to fling masses of untrained troops at the enemy, allowing regiment after regiment to be mercilessly slaughtered until by mere numbers the battles can be won. The advocates of such a campaign of defense should be the first to go to the front—otherwise their voices for a small expenditure on National defense show merely an intention on their part to sacrifice the lives of the patriots of the country in unreasonable numbers in order to save their pro rata of the increased expense by another policy.

In contrast with such a policy, the officers of the U. S. Army at Santiago showed a regard for the lives of the privates similar to the love of a miser for his gold. Having been "orderly" during that engagement I was in position to learn the attitude of nearly every officer in my regiment, and I repeatedly saw officers show less regard for their own danger than for the danger of their men. No doubt the Army and Navy in asking for money, and still more money, think more of the lives of men than of the pocketbooks of citizens. Indifferent and cold-blooded sacrifice of men in mass formations has not won for any European Nation, and the U. S. Army seems to have been justified in its humane tactics. I am sure that the mother of each soldier in that war is glad that our military strategy is not based on the theory of hurling men against hot steel faster than they can be mowed down.

The suggestions by Mr. King are excellent. If the work of these engineers could be made secret, our safety would be greatly increased. The submarine was invented in the United States. If it had been secretly monopolized by the United States it would have saved the necessity for many battleships. The object of wars is to kill the enemy as quickly as possible. A simple invention to make every soldier a sharpshooter, secretly owned by the United States, would multiply the strength of our Army many times. Besides giving the young engineer military training, there should be a secret Bureau of Military Research to preserve for the United States alone the best work of our engineers for military defense.

G. B. Baskervill, Jr.
Birmingham, Ala.

To Compute Offsets to Vertical Curves

Sir: I read with considerable interest Leopold Pistner's article on computing offsets in circular curves in your issue of Feb. 6, page 171, which recalled to my mind a statement in the preface of a well-known engineers' pocketbook to the effect that the simplest facts may be buried under heaps of mathematical rubbish.

As stated in the article, the form

$$y = R - \sqrt{R^2 - x^2}$$

is not convenient for logarithmic computation. Instead of using the binomial theorem, however, why not factor $R^2 - x^2$ and say

$$y = R - \sqrt{(R + x)\ (R - x)}$$

Using the figure given in Mr. Pistner's article,

$$\begin{array}{rl}
R = & 200.000 \\
x = & \underline{\ \ 75.397} \\
(R - x) = & 124.603 \\
(R + x) = & 275.397 \\
\log 124.603 = & 2.0955285 \\
\log 275.397 = & \underline{2.4399592} \\
 & 2/4.5354877 \quad R = 200.000 \\
 & \ \ 2.2677438 = \log \underline{185.244} \\
 & \qquad\qquad y = \ \ 14.756
\end{array}$$

The above method, which the writer has used for several years, may also be applied to the reduction of inclined measurements to horizontal distances. Let M = the inclined measurement; E, the difference in elevation between the points measured, and H, the horizontal distance. Then

$$M^2 = H^2 + E^2$$

$$H^2 = M^2 - E^2 = (M + E)\ (M - E)$$

and

$$H = \sqrt{(M + E)\ (M - E)}$$

As an example, let $M = 98.675$ and $E = 4.317$. Then the solution is as follows:

$$\begin{array}{rl}
M = & 98.675 \\
E = & \underline{\ \ 4.317} \\
(M - E) = & 94.358 \\
(M + E) = & 102.992 \\
\log 94.358 = & 1.9747787 \\
\log 102.992 = & \underline{2.0128035} \\
 & 2/3.9875822 \\
 & \ \ 1.9937911 = \log H \\
 & \qquad\qquad H = 98.581
\end{array}$$

Willam A. Cunningham,
Draftsman, New York Public Service Commission for the First District, Sixth Division.
New York City.

[The simplification of the original problem by factoring the expression $R^2 - x^2$ is also pointed out by E. M. Walker, grade separation engineer of the Michigan Central Railroad, Detroit, and by J. K. Barker, of Springfield, Mass.—Editor.]

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Sheeting and Pumping Methods for Chicago Sewer Trench

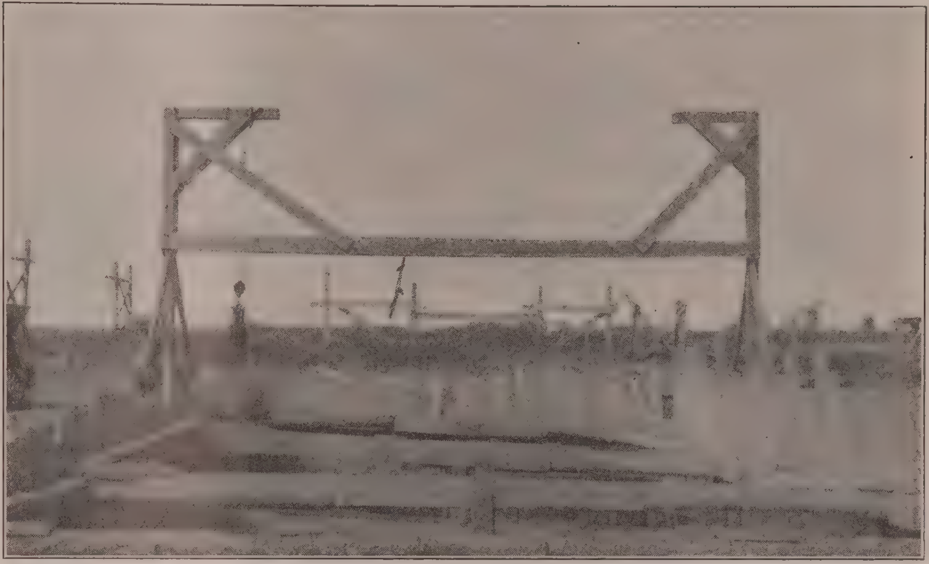
A LARGE part of the trench for the West Ridge sewer in the Sanitary District of Chicago was in stiff clay, which was readily excavated by a steam shovel mounted on a trussed timber frame spanning the 7-ft. trench. About 1300 ft. of the line, however, was in quicksand for the lower 12 ft. of excavation, and in dry, fine sand for the upper 8 ft.

The dry excavation was done by the shovel in the same way as the excavation in clay, and the trench was braced with wood sheeting, two lines of wales, and struts, as shown in the photographs. The struts each have a light shoring jack at one end.

Behind the shovel in this section of trench followed a gang driving 9-in. United States steel sheeting, 12 ft. long. These piles were jetted down with two ¾-in. streams supplied from hydrants. Some driving with mauls was required, but piles were usually sunk with jets alone in less than one minute each. The water was then lowered by pumping from numerous well points (shown in one of the pictures) driven at the side of the trench and connected through a suction header to a triplex pump driven by an 8-hp gasoline motor. About 300 ft. of trench was unwatered at a time

As the water level was lowered excavation proceeded by hand, the steel sheeting being braced with two runs of wales and struts, spaced 2 ft. and 8 ft. below the top of the steel. As fast as the excavation reached the required 20 ft. depth the brick invert of the sewer was laid behind the diggers, followed as fast as possible by the brick arch. The brick work was closely followed by a locomotive crane with a ¾-yd. orange peel running beside the trench, which backfilled to the top of the steel, pulled the steel with a chain attached to its bucket, and then filled the remainder of the trench.

The contract work is being done by M. Pontarelli, for the sewer department of the Board of Local Improvements. C. D. Hill is chief engineer for the board and H. E. Hudson, assistant engineer.


INEXPENSIVE TRAVELER SAVES TYING UP DERRICK TO DRIVE WOOD SHEETING

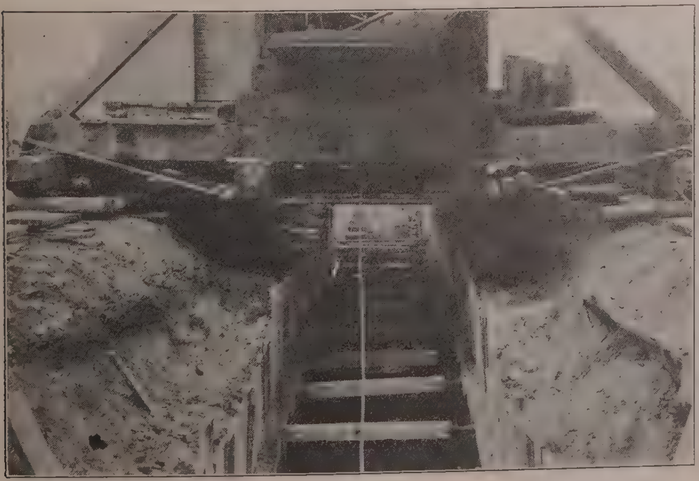
Traveler Supports Steam Hammers for Driving Wood Sheeting

A TRAVELER which spans the trench and supports two light steam hammers for driving down sheeting as excavation progresses is shown in the accompanying photograph. The traveler is made up of 8 x 8-in. timber and 3-in. plank. Hand crabs are provided for handling the hammers. While this device is not new, it is probable that many of our readers have never seen it. Its use for driving wood sheeting is obvious. This type of sheeting will not stand driving in advance of the excavation, and this rig saves tying up a derrick every time it is necessary to drive some of the sheeting down.

The photograph shows a 30-ft. trench for one of the side walls of the main pumping station on the Passaic Valley sewer. These piles have penetrated so far that they can no longer be driven by hand, but it is probable that in ordinary ground driving with the hammer is cheaper than hand driving in any case. On this job, however, the first 10 or 12 ft. penetrated was very soft swamp ground, and it was found advisable to drive the sheeting by hand as low as the long cross-brace on the traveler.

Construction Superintendent Favors Paying Off in Cash

PAYING the contractor's force in cash is always desirable where it can be arranged. Except on remote work, where large sums of money would have to be carried through unsafe territory, it should always be done. A construction superintendent recently expressed the following opinions on this subject:


STEAM SHOVEL MOUNTED ON FRAME TO SPAN TRENCH EXCAVATION

SUCTION MAIN CONNECTED TO WELL POINTS FOR UNWATERING TRENCH IN QUICKSAND

"The check system of paying has several disadvantages. Most American workmen are forced and led to cash their checks in saloons. This leads to drunkenness around pay-day, and to the running of drink accounts by some men with the saloonkeeper who cashes their checks. Many foreign workmen are either subjected to the same evil or, through ignorance, pay a commission to some countryman in order to get their money. Most banks require that identification be waived on contractor's payroll checks, so that as evidence of payment these handled checks are worthless.

"Paying by check makes endless office work. To write checks for a $5000 payroll is at least 6 hr. work, and signing and countersigning them takes a couple of hours more. With the assistance of one other man I have often 'plugged' with cash the envelopes for a payroll this size in less than 40 min. Further, it is the general custom to use one bank account for payroll and material checks because men must unavoidably be paid off between paydays and it is desirable to use the money on hand for buying supplies for this purpose. This makes confusion and extra work in arriving at a balance with the bank. Even when there is an adding machine in the job office, as there should be on every large job, checking back to the bank sheet and stubs and listing and adding payroll checks to get a balance is no small task. The only things to be said in favor of the check system are its comparative safety from robbery, and the fact that many men are encouraged to save by carrying some of their payroll checks with them till the end of the job. This last argument is now offset, however, by the large use workmen are making of the postal savings bank.

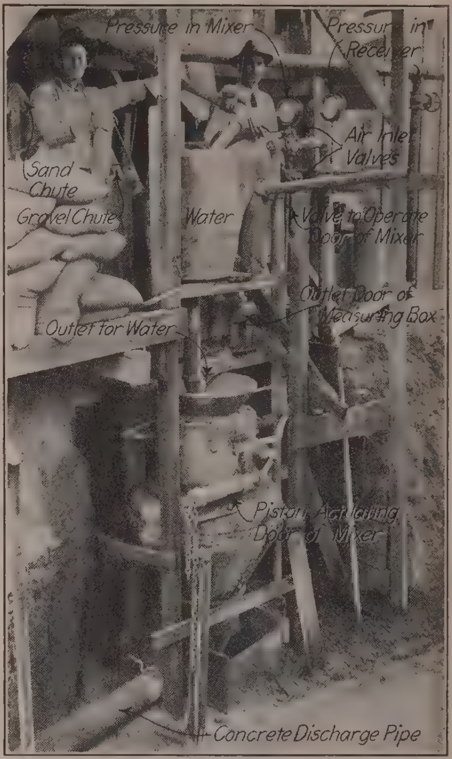
"If you pay off in cash, you must keep some money on the job between paydays to take care of discharged employees. For this purpose one office man should be bonded, and should have a good safe to which he alone has access. Where it is absolutely necessary to pay by check these things should be borne in mind: First, supply the job with an adding machine. Second, use loose-leaf check books for your payroll checks. They will save 30 per cent of the time required to make out checks. Third, have your payroll account at the bank separate from your material account. When the former runs low, deposit a check to its credit from the material account. Fourth, do not countersign payroll checks, and have them signed by some office man on the job beside the superintendent. This man should be put under bond. He will be always on hand to pay off discharged employees as readily as if they were paid in cash."

Pneumatic Outfit Delivers Concrete 1300 Feet to Tunnel Forms

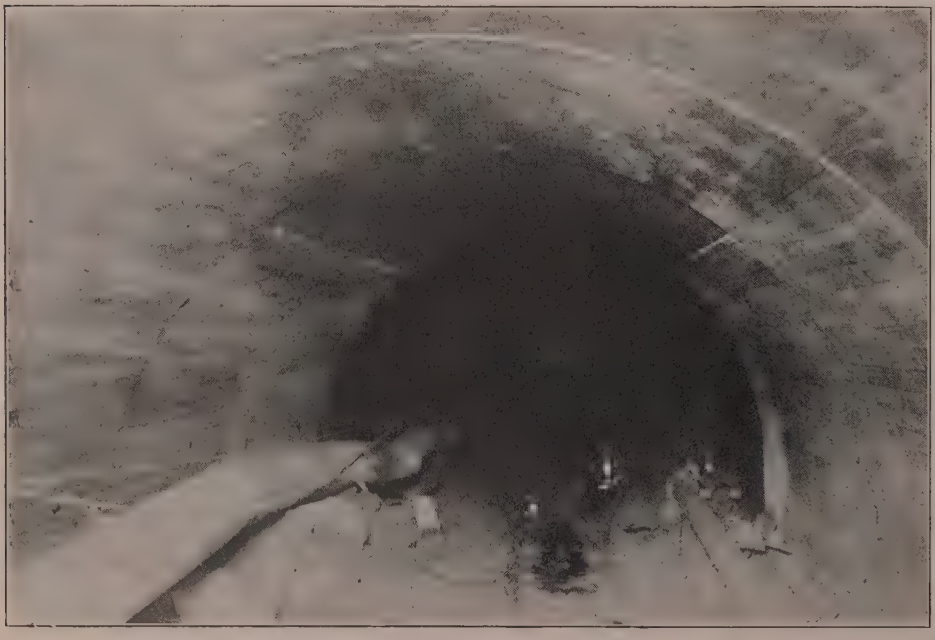
Concrete has been mixed and placed with compressed air in constructing a 9 x 11-ft. horseshoe-shaped sewer tunnel in San Francisco, described elsewhere in this issue. The tunnel, which is approximately 4380 ft. long, extends north from Carrillo Street under Sutro Heights to its outfall in the Pacific Ocean.

The construction work is being handled from two adits, 3116 ft. apart, one of which is at right angles to the tunnel, and the other at an angle of 20 deg. with the center line. Three 8-hr. shifts a day work in each heading. Two shifts excavate a section and the third shift concretes it. In the south heading drilling is done with two Little Jap hand drills, and 25 to 30 lb. of 40 per cent dynamite is used to a shot. In the north heading, however, the rock has been harder and has required two piston drills mounted on columns, cutting an average of eighteen 6-ft. holes and requiring from 50 to 70 lb. of dynamite per shot. The headings had to be timbered, but required lagging only in a few places. Muck was removed in ¾-yd. narrow-gage cars drawn by mules, and dumped near the mouths of the adits.

The compressed air plant which supplies air for the drills is also used for the pneumatic mixing and placing of concrete. An Ingersoll-Rand two-stage compressor with a capacity of 1100 ft. of free air per minute is in service. A receiver of 120 cu. ft. capacity is located at the mixing machine. Each mixer and conveyor is placed in a nitch at the side of the adit, and is charged by material from gravity bins erected over it. One-quarter yard batches have been mixed and delivered 600 ft, away at an average of sixty batches per hour. At the present time the conveyor pipe is about 1300 ft. long, and thirty-two batches per hour are being placed. It is intended to extend the pipe line to a length of 2000 ft. The delivery pipe is laid along the floor of the tunnel and through the forms, where it turns up with a 90 deg. bend, turns back with a 90 deg. bend, and enters the forms at the crown of the arch. A heavy rubber hose about 4 ft. long is used on the end of the pipe for distributing the concrete. The finished concrete is very dense, as is well shown in the accompanying cut. The impact of concrete being delivered at high velocity on the mass already in the form compacts the material and forces the grout against the form surface.



PNEUMATIC PLANT FOR PLACING CONCRETE IN MILE ROCK TUNNEL



FINISHED TUNNEL—THIS CONCRETE SURFACE MADE WITHOUT SPADING

The excavation in each heading requires a foreman, four miners, and six shovelers. The concrete is placed by two men at the mixer and two men at the form. Electric signals are used between the form and the mixer to regulate the delivery of the concrete. A 1:2½:5½ mixture is used. The contractor for the work is R. C. Storrie & Company. The concreting is being done by the Pacific Concrete Placing Company, with tools leased from the Concrete Mixing & Placing Company, of Chicago. The work, which began last August, will require a year all told for completion.

Roads for War Relief have been largely accepted as a logical measure in Canada, and while rural municipalities, with a continuance of good crops and prices, will be in an excellent position to carry on the work, the ability of provincial governments to aid large undertakings may not be correspondingly favorable. In Canada, according to W. A. McLean's presidential address before the American Road Builders' Association at Chicago, private capital has, in at least one instance, stepped into the breach and the construction of a concrete highway from Toronto to Hamilton, about 40 mi., has been organized and commenced since Sept. 1.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Drydock Wrecked in Launching Cribs at Victoria

Premature Flooding of One Side Tilts Dock Till Concrete Cribs Shift, Tearing Out Starboard Side—Cribs Uninjured

A floating drydock was wrecked Jan. 30 at Victoria, B. C., when an attempt was made to launch from it two reinforced-concrete cribs which were the first of fifty-four such cribs to be floated into place in carrying out the harbor development scheme.

The mishap is believed to have been brought about by the premature flooding of one of the compartments, which caused the vessel to list to starboard. As the drydock keeled over slightly, the weight on the floor of the craft began to slip from its position and the drydock listed until its edge appeared to touch bottom. Here it held for a few minutes, and then the cribs went overboard, wrecking the starboard side of the drydock and at the same time carrying away the overhead traveling crane and the timber supports. The drydock, it is believed, will be a total loss, but the engineers on the work are of the opinion that the concrete cribs can be salvaged. The tops of the cribs are now visible above water, and from all appearances they are intact.

The drydock was chartered for this work from a Seattle firm, and before being put in service was strengthened so as to be able to carry the concrete cribs, which weigh 3,500 tons each. Several months were occupied in putting it in shape for the work. It was refloored, and strongly timbered supports were erected on either side of the craft to carry the traveling crane overhead. When the alterations were completed the vessel was declared to be sound in every respect, and everything necessary to put it in the best condition for the work was thought to have been done. A description of the reinforced-concrete piers and the proposed method of handling them appeared in the Engineering Record of Jan. 17, 1914, page 80.

Water Supply System Offered to San Francisco for $34,500,000

The Spring Valley Water Company of San Francisco has formally offered to sell to that city for $34,500,000 certain of its water rights and other properties which the city desires in developing its own municipal water-supply and distribution system. This is in accordance with the endeavor being made by both parties concerned to settle out of court the condemnation suit which has recently been instituted by the city and which now promises long delays that would handicap the city as well as interfere with the company's construction program for the maintenance of the system.

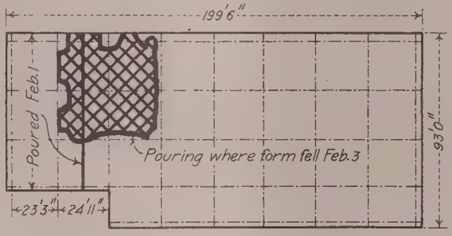
The Board of Supervisors recently passed a resolution calling upon the Spring Valley Water Company to supply, in addition to the description of properties offered, information as to the probable cost of increasing the present capacity to 60,000,000 gal. per day. In replying to this request, the company stated that "Under present conditions the main supply pipe lines of the company are developed for a daily delivery to the city of 51,000,000 gal. and are used to convey this quantity whenever the demand requires. The sources of supply of the company are at present developed to yield 40,000,000 gal. daily, and any excess in daily draught over this amount must therefore be drawn from storage."

The Calaveras dam, which controls only a portion of the watershed of the Alameda system, is now in course of construction, and the engineers of the company estimate that when this dam is completed it will impound 58,257,000,000 gal. "It is our present opinion," the letter from the company concludes, "that a total supply of 60,000,000 gal. daily can be brought to San Francisco by an expenditure for structures in addition to those now utilized of approximately $2,495,940."

Forms Fail in Ford Building at Fargo, North Dakota

Forms failed Feb. 3 under the second floor of the Ford service building at Fargo, N. D., while concrete was being poured. Two of the men who had rushed in to place props under the threatened section were smothered in green concrete and débris. Their four companions escaped with minor injuries.

Four panels were being poured at the time, and all went down, carrying with them a small portion of the floor poured two days previously. The form supports for this floor were inclined posts resting on the column footings, which were at ground level. Because of soil conditions it did not seem feasible to support the floor framing in any other way. The first-floor columns had been cast for about three weeks, and all remained plumb and in line after the accident. The whole work was housed in. The skeleton of the forms for the third floor had been erected, and had been covered with boards. This protection collapsed at the time of the accident, and resulted in the freezing of considerable green concrete which did not actually fall. This is being removed and the work of reconstruction carried on as rapidly as circumstances will permit.



PLAN OF FORD BUILDING
Shows collapsed area.

The only theory which has been advanced for the accident was that some local defect in the formwork of the one panel which collapsed first caused this work to give way gradually, and to fall before it could be secured.

$2,000,000 Road Bond Issue Awaits Legal Action

Providing the courts hold legal the recent vote for a $2,000,000 Cook County road bond issue accepted by Chicago's citizens last November, $400,000 will be spent this spring in improving the county highways. The county board Feb. 8 passed resolutions which provide for the issuing of $200,000 of the bonds each year for 10 years. Under the Tice law the State will appropriate an equal amount. The roads to be benefited if this plan is carried out are the extensions of surfacing on Milwaukee, Archer and Western Avenues and South Halsted Street.

Big Chinese Flood Loan Held Up

Owing to unsettled financial conditions, China has extended for one year from Jan. 1, 1915, the option held by American bankers to raise a loan of $20,000,000 to eliminate devastating floods in the Huai River valley. Formal notice of the action was given the U. S. Government Feb. 8 from the legation in Peking.

Sewage Aeration Experiments to Begin at Baltimore

U. S. Public Health Service and Baltimore Sewerage Commission to Cooperate in Important Investigations of Activated Sludge

The U. S. Public Health Service and the Baltimore Sewerage Commission have completed preliminary plans for conducting jointly at Baltimore a series of experiments on the aeration of sewage. Prof. Earle B. Phelps will direct the work for the Health Service, with Leslie C. Frank in charge of the experimental plant, while the Baltimore Sewerage Commission will be represented by its chief engineer, Calvin W. Hendrick. From Professor Phelps and Mr. Hendrick the following information regarding the scope of the work has been obtained:

Recent English results on the aeration of sewage seem to supplement the work which Col. William M. Black and Professor Phelps did at Brooklyn some years ago and to explain certain irregularities which interfered with its complete success. It is proposed, therefore, to elaborate those earlier experiments, making use of the activated sludge principle developed by the English workers.

One of the new Imhoff tanks at the Baltimore works will be slightly modified so that it can be used to test the effect of aeration upon a practicable scale and also to make a continuous flow process which is essential if practical use is to be made of the English principle.

Los Angeles Considering Construction of Subways

The City Council of Los Angeles has instructed the board of public utilities to make a study of the question of building about 3 mi. of subways in the congested district of the city and submit an estimate of costs with a report on the traffic and franchise conditions. Meanwhile there are being debated methods of financing the proposed construction, questions of franchise rights when the subways are ready for service and other matters involved.

It is agreed that the present congestion in the narrow streets of parts of the business district must be relieved, and the construction of subways was regarded as the most feasible means of accomplishing this. It is proposed that two subways be built, one under either Spring or Broadway to extend from Tenth to Temple Streets, while another would run under Seventh from Figueroa to Los Angeles Street. It has been estimated that the cost of the subways would be roughly about $1,000,000 per mile.

New Reservoirs in New York State

Construction, control, maintenance and operation of storage reservoirs to conserve the flood waters and regulate the streams are recommended in a report of the New York State Conservation Commission to the Legislature at Albany. The commission recommends that the cost of constructing and maintaining water storage reservoirs be levied upon the State and the municipalities benefited and also in part on the owners of water-power sites, undeveloped as well as developed.

A tabulation is presented showing that the construction of a reservoir on the Sacandaga River, at an estimated cost of $5,000,000, would increase the total low-water power of the Hudson River at the developed sites below Hadley from 29,500 to 91,300 hp and at undeveloped sites from 8885 to 61,500 hp. Similar results would follow the regulation of the Genesee, Black, Raquette and Saramas Rivers.

Prompt action for the development and utilization of 1,500,000 hp at present undeveloped is urged.

Edison Fire Eagerly Discussed at Concrete Institute

Richard L. Humphrey Relinquishes Presidency to Leonard C. Wason After Ten Years of Continuous Service

The Edison factory fire provided the subject for the most intense and spectacular of the numerous reports and papers presented at the eleventh annual convention of the American Concrete Institute, held in Chicago, Feb. 9, 10, 11 and 12. Scarcely of less interest was the lantern-slide talk, not on the program, on "A Microscopic Investigation of Concrete in Sea Water," by Nathan C. Johnson. He presented many of the micro-photographs illustrated in the series of articles now running in this journal. The report of tests on large-sized concrete columns came in for serious discussion.

After ten years of service Richard L. Humphrey relinquished the presidential duties to Leonard C. Wason. Financially the organization is in excellent condition through the private subscription of some $17,000 during the past year. It was finally concluded to raise the dues to $10 per year, as it has been fully determined that no National association can exist and carry on effective work at the former $5 fee, although the membership has now reached 900. A secretary devoting all his time to the Institute is an innovation, and Charles L. Fish has been appointed to that task. Edward E. Krauss, who has filled the office for several years, retires to look after his private interests.

First Day's Session on Roads

Concrete road building, including present practice, service tests, reinforcing, maintenance, costs, highway bridge and culvert design and construction, was the subject of the first day's discussions. "Comparative Costs of Concrete Roads," by Percy H. Wilson, was a paper containing data collected from all over the United States. Most widely discussed were the new and revised specifications presented by the committee on concrete roads by W. M. Kinney. Many minor changes were made in last year's specifications, and new items were added for integral curbs and one-course alley pavements. The growing tendency to eliminate metal-protected expansion joints was provided for in a clause advocating the use of a split float so as to finish the pavement each side of the filler at the same time. H. J. Kuelling has been rounding off edges of unprotected joints with a 1½-in. radius tool on Milwaukee roads, but the experience was considered too experimental as yet for adoption. Mixing in a batch mixer for at least 1 min. at a maximum speed of 12 r.p.m. replaces the old requirement of 45 seconds. Several members argued for a much longer period. The committee felt that too much water has been used on road work, and the consistency paragraph now requires sufficient water to produce a concrete which will hold its shape when struck off with a template. Disputes over aggregates will be lessened by the new clause requiring 50-lb. samples to be submitted by the contractor before delivery.

Sanford E. Thompson presented numerous views of the construction of the Massachusetts Institute of Technology buildings and described the field test methods employed, one of which consisted of obtaining samples of the concrete which actually went into the forms for 8 x 16-in. compression cylinders.

Lively discussions followed papers by C. A. P. Turner and Edward Godfrey. Both men severely criticized the Joint Committee Report and several city building codes with special reference to the reinforcing of columns and flat-slab construction. Mr. Godfrey would eliminate the rodded column, replacing it by plain or hooped columns. Mr. Turner believes too much reinforcement goes into floor slabs. Prof. A. N. Talbot defended the report, declaring that the reinforced column has its place. Tests show, he said, that this steel takes stress.

Dusting of Floors

Dust prevention formed the subject of a paper by P. M. Bruner, in which de described substantially the same method as reported in the Engineering Record of Dec. 5, 1914, page 607. Mr. Wason then led a discussion on the same subject. Dry mixes and exclusion of fine sand were two points he insisted were necessary. To prevent dusting in old floors boiled linseed oil and silicate of soda had both given him good service. The former was preferred.

Edison Fire Report

Progress of the Edison fire in some striking views taken at night were followed by numerous pictures showing details in the report of a special committee headed by Cass Gilbert. In the course of the discussion T. L. Condron showed by slides the methods used in the repairs. Rather startling was the disclosure of several columns broken entirely in half, but not discovered until the workmen had chipped off the outer concrete preparatory to making repairs. Needless to say these columns were shored as soon as found, although the loads had been successfully carried for two months. Mr. Condron showed diagrams of tests of floor-slab panels with loads of 250 and 300 lb. per sq. ft., which showed remarkably good results considering the fact that under each slab were some columns so badly damaged as to require shoring. The grout is poured into the forms surrounding the columns and the enlarged beams and girders through holes cut in the floor slabs. So urgent are the demands for the resumption of business that the repairs are being made in some of the floors at the same time that manufacturing operations are carried on. So far the pouring method has proved to be the quickest way to make the repairs.

Contractors' Session

One whole session was devoted to the contractor. T. A. Smith described the contractor's equipment on the Austin-Nichols Warehouse in Brooklyn, William P. Anderson told of a mechanical plant for handling concrete which his company had used successfully, and Harrison S. Fish added a valuable contribution to the existing data on strength of concrete forms. This was printed in the February issue of the Institute Journal. Alfred D. Flinn sent a paper on "Concrete Forms for the Catskill Aqueduct."

The report of the committee on methods of tests, of which Sanford E. Thompson is chairman, gave data on the comparative strengths of concrete in which the sand size was varied. In general the highest strengths were found with sands graded from 0 to ½-in. size. The committee requests the co-operation of testing laboratories throughout the country. Problems on which work is desired have been outlined. Co-operation will avoid duplication. Among the resolutions passed was one calling on the directors to bring before building departments and insurance engineers the standards adopted by the Institute.

The officers for the ensuing year are: President, Leonard C. Wason; vice-presidents, W. K. Hatt and H. C. Turner; treasurer, Robert W. Leslie, and directors, W. H. Ham, Ernest Ashton, A. E. Lindau and W. P. Anderson.

Defeat Sanitary District Project in Indiana

The popular vote on the question of establishing a Sanitary District of Northern Indiana to care for the watershed of the Calumet River in Lake County was recently adverse to such a measure. East Chicago and Hammond were strongly against the project on account of the high proposed costs.

Discuss Status of Engineer

Eminent Members of Profession Give Their Views at Midwinter Meeting of Electrical Engineers

A large body of engineers gathered in the United Engineering Societies Building, New York, on Feb. 17 to hear the views of distinguished members of the profession on the status of the engineer. The session was part of the program of the midwinter meeting of the American Institute of Electrical Engineers and was presided over by the president, Paul M. Lincoln. The speakers were George F. Swain, professor of civil engineering, Harvard University; Louis B. Stillwell, consulting engineer, past president of the American Institute of Electrical Engineers; E. W. Rice, president of the General Electric Company; E. M. Herr, president of the Westinghouse Electric & Manufacturing Company; H. G. Stott, superintendent of motive power of the Interborough Rapid Transit Company; A. C. Humphreys, president of Stevens Institute of Technology, and J. J. Carty, chief engineer of the American Telephone & Telegraph Company.

In general the speakers deprecated the lack of participation of the engineer in public affairs, and urged a broader education for those preparing for the profession. Mr. Stillwell urged upon the national engineering societies the necessity for disciplining their members for conduct unbecoming professional men, in order that the societies may command the confidence of the public.

In pointing to the opportunities in large industrial organizations for men with the training and ideals of the engineer, Mr. Rice made this significant remark: "Big business is doomed to failure unless it is saturated with honesty." Mr. Herr urged that the young engineer keep in mind constantly two slogans—progress and improvement—which are basic in all worth-while engineering work. He laid especial emphasis, as did Dr. Humphreys and Mr. Stott following, on the part which ability to handle men plays in the success of the engineer. All of them deprecated a definition which confines the engineer's work to inanimate forces and materials.

The most scholarly address was that of Professor Swain. His thesis was that if the engineer fail to secure the recognition he deserves, there must be a good reason, and he then proceeded to make an analysis to discover this reason. He weighed the value of the elements entering into what he summed up in the word personality, these elements being, in part, character, presence, ability to handle men, tact, logical thinking, and breadth of view. Proceeding further, he sought to discover to what extent these elements are native gifts and to what extent they may be developed. Comparing engineers as to these various attainments or characteristics he found that engineers generally rank below lawyers and business men, and to that he attributed the lower standing of the profession in public esteem. The remedy, to his mind, lay largely in education, and he sketched the requirements of a curriculum of the necessary breadth.

New Engineering Medal

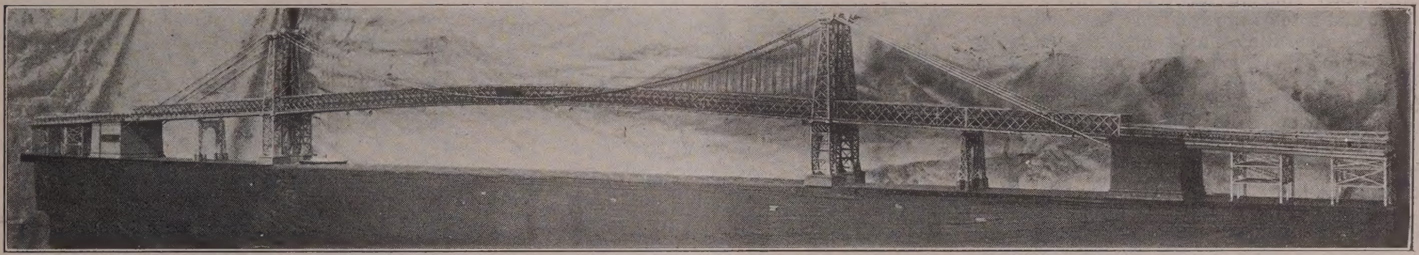
A new prize, the Leonard C. Wason Medal, is to be awarded annually by the American Concrete Institute to the author of the most meritorious paper published by the institute during the year, unless the board of direction decides that none of the papers presented is of such character as to merit the award. The governing conditions are that the competition shall be restricted to members of the institute, and that all original papers presented to the institute by members and published by the institute during the year for which the medal is awarded shall be open to the competition, provided that such papers shall not have been previously contributed in whole or in part to any other association nor printed elsewhere prior to presentation.

Real Water for Canada's Power Plant Models at Exposition

A water power exhibit, believed to be the most extensive ever shown, has been installed at the Panama-Pacific Exposition by the Dominion Water Power Branch of the Department of the Interior, Canada. It consists essentially of two large oil paintings, one of Canada, 9 x 70 ft., the other of Niagara, 10 x 40 ft., and eleven models of typical water power developments supplying the various industrial centers throughout the country. The locations of the more important developed and undeveloped power sites in Canada are shown on the large painting, while the models are accurate in scale and detail and have water flowing through the various water courses, sluiceways and power houses, representing actual operating conditions.

Model of Williamsburg Bridge Made for Exposition

Accurate as to detail and made entirely of steel shapes and wire cables, the 26-ft. model of Williamsburg Bridge, which was made by the John A. Roeblings' Sons Company under the supervision of Morton L. Fouquet, will be one of the principal features of New York City's exhibit at the Panama-Pacific International Exposition. An attractive setting has been provided, reproducing the water fronts of East River and the view as obtained from the Manhattan Bridge. This model, which is shown without the scenery in the accompanying photograph, forms only a small part of the very effective exhibit prepared under the appropriation of $100,000.



THIS MODEL OF THE WILLIAMSBURG BRIDGE IS 26 FEET LONG AND IS PART OF NEW YORK CITY'S $100,000 EXHIBIT

Guarding Against Colorado River Floods

An appropriation of $250,000 for the work necessary to protect the lands and property in the Imperial Valley, California, against overflows of the Colorado River has been asked in a report made by Gen. William L. Marshall, consulting engineer, to the Secretary of the Interior. The floods of 1914 threatened this valley, but the danger was averted by protection work done with Federal and local funds, as described in the issues of Engineering Record of Aug. 8 and 29, 1914, pages 155 and 242 respectively.

Pennsylvania Railroad to Exhibit Huge Map at Exposition

An elaborate exhibit will be displayed by the Pennsylvania Railroad at the Panama-Pacific Exposition. Among the features there will be a topographical map 42 ft. long and 26 ft. wide of the territory served by the Pennsylvania system; a miniature reproduction, 26 ft. square, of New York City and its immediate surroundings, showing correctly the railway stations, skyscrapers and other large buildings, and models of the Pennsylvania Station in New York, the Washington Union Station, the proposed Union Station at Chicago and the main span of the Hell Gate Bridge. Statistical information as to the company's mileage, equipment, volume of business and expenditures will be in evidence, and to acquaint visitors to the exposition more fully with the Pennsylvania system the company will conduct a moving picture theater, showing pictures that have been in course of preparation for a year or more.

Colonel Goethals—A Newspaper's Comment

The following editorial note appeared in the New York Evening Post of recent date:

"This man, Col. Goethals, must have something wrong with him. It is apparently not his liver, despite his life in the tropics, but somehow he has been affected so as to make his appearance before a Congressional committee seem abnormal. First of all, he will utter no predictions, and will give no guarantees. Will the battleships be able to sail through the Panama Canal on the day fixed? Col. Goethals replies that he cannot tell. All will depend upon what is going on in the Culebra Cut, on that date. Then he had grave fears about the future of the canal? Not at all. He had dredges to take care of the slides as fast as they occurred. Anyhow, Col. Goethals must feel concerned about the military defences of the canal. Couldn't a Japanese or German fleet come and seize it at any moment? Col. Goethals thought not. The fortifications were ample. But didn't he want bigger guns? No, those he had were big enough. But this is absolutely dazing. Representative Gardner ought at once to move an inquiry into the state of Col. Goethals's defences."

Call for Delegates to International Engineering Congress, San Francisco

The success of the International Engineering Congress to be held Sept. 20 to 25 in San Francisco now seems, in spite of the present European war, to be assured. The committee on papers is able to count on from 200 to 250 papers and reports covering all phases of engineering work, contributed by authors representing eighteen different countries. The committee on management is now issuing to all important engineering societies, in this country and abroad, invitations to appoint official delegates to attend the sessions of the Congress, and the presence of a considerable body of such delegates is well assured. Membership in the Congress with the privilege of purchasing any or all of the volumes of the proceedings is open to all interested in engineering work. W. A. Cattell, secretary of the Congress, may be addressed at 417 Foxcroft Building, San Francisco.

Railroads Guard Against Flood Damage in Southern California

Profiting by the floods experienced last year in the southern part of California, three railroad companies have completed construction work calculated to guard against a repetition of the damage and interruption of service. On the Los Angeles division of the Santa Fé it is stated that over $100,000 has been expended in the last few months in widening cuts, reveting embankments, and arranging generally for drainage and control of streams along the right of way. Permanent bridges costing $382,000 have also been erected.

Officials of the Southern Pacific stated that that road has recently expended approximately $200,000 on permanent bridges on the coast and valley routes south of San Francisco. The exact cost of flood protection work on the San Pedro, Los Angeles & Salt Lake Railroad has not been compiled, but officials of that road stated that every bridge damaged last year by the high water has been replaced by a modern structure of concrete and steel, and that concrete culverts have been placed wherever needed on the southern California lines.

Highway Association Report Ready for Use of Legislatures

To many of the forty-two State Legislatures now in session the preliminary report of the legislative committee of the American Highway Association should prove most helpful. The committee has already compiled the road laws of each State in the Union complete to Jan. 1, 1915, and has also completed a thorough index so that the great mass of material in the report can easily be consulted for purpose of revision.

The committee is formulating basic outlines for efficient road legislation. Fairfax Harrison, president of the association, has advised the governor of each State that the committee stands ready to place its data at the disposal of State legislators and to arrange for specialists on the subject to confer with State officials and legislative committees which now have under consideration the framing of road laws. At present thirty States make direct appropriations of State funds for road construction, and only seven States are still without a highway department, so that great progress has already been made. The most immediate and pressing problems are those relating to the construction, maintenance and control of local roads and bridges.

The American Highway Association, in devoting a large part of its attention to the work of the legislative committee, is proceeding on the theory that since State legislatures control the financing and management of most public roads, it is with them that any effective reform must begin. The personnel of this committee brings to the work the various kinds of experience and knowledge essential to an adequate handling of the subject. Serving on the committee are Walton Moore, a lawyer of national reputation; A. N. Johnson, chief engineer of the Bureau of Municipal Research; Charles J. Bennett, State highway commissioner of Connecticut, and J. E. Pennybacker, chief of road economics of the U. S. Department of Agriculture.

Investigating Pittsburgh Sewer Explosions

The Bureau of Mines is co-operating with the city of Pittsburgh to determine the causes of recent sewer explosions. By the use of special methods and apparatus many samples of sewer air have been collected and analyzed. Gasoline has been introduced into sewers with special precautions to prevent accidents, and the quantities of different kinds of gasoline required to produce explosive mixtures under different conditions have been determined.

The studies have also taken into consideration the intrusion of natural gas, artificial gas, washings from garages and residue from cleaning plants, and also the possible sources of ignition. A report will be published as soon as sufficient data have been obtained. The work is under the supervision of O. A. Burrell, of the Bureau of Mines, and N. T. Boyd, city chemist of Pittsburgh.

Chicago Produce Business to Be Bodily Relocated

It is proposed to lift the produce business of Chicago from its present location on South Water Street, the heart of the retail district, and set it down several miles away, still on the banks of the Chicago River, but with direct railway connection with all lines. The project involves $20,000,000 and is being financed under the name of the Produce Terminal Corporation by the Chicago Junction Railway. To date $6,000,000 has been expended for the new location, which is bounded by Thirty-ninth Street and the tracks of the Chicago Junction Railway on the north and south, and by Ashland and Western Avenues on the east and west. This site has a solid mile of water front and a total area of more than 100 acres.

The corporation has completed plans for housing in this region all the fruit and produce interests in Chicago. It is estimated that the buildings and other facilities will cost $14,000,000. In the expenditure is included $3,000,000 for a central storage plant, stores to house 188 firms, docks on the river, team tracks and warehouses on the Junction Railway tracks, an administration building and three produce and display buildings.

Produce moving to and from the terminal will not have to pass through the congested railway terminals of the city proper, and the time in transit, therefore, will probably be shortened from 24 to 48 hours. The site of the proposed terminal adjoins the Ashland Avenue freight yard of the Chicago Junction Railway and a total capacity of more than 10,000 cars is provided within and adjacent to the terminal.

The terminal will be located on the south fork of the south branch of the Chicago River, and the plans contemplate development to care for future transportation by water. The river at this point is 200 ft. wide, and will be dredged to sufficient depth to take care of the largest lake boats. The question of providing lighterage service to different points on the river is under consideration.

How Fast Does Water Flow Through a Reservoir?

William Mulholland, chief engineer of the Los Angeles Aqueduct, has recently been undergoing cross-examination in the suit to prevent the city from using the aqueduct water. The subject under consideration at a recent session happened to be the Hairvee reservoir.

"Mr. Mulholland," said the counsel for the plaintiff, "how fast does water flow through a reservoir?"

"What's the use of answering a question like that?" Mr. Mulholland replied. "That's about as silly as how big is a piece of chalk. How do I know?"

Unanimous Action on Flood Prevention Bill

After one important amendment had been adopted the Indianapolis flood-prevention bill was sent to engrossment in the Senate Feb. 1. The amendment, which was favored by both Republicans and Democrats, provides that 10 per cent of the cost of flood-prevention work shall be paid by the property benefited, 45 per cent by the county and 45 per cent by the city.

The original provision was that 20 per cent should be paid by benefited property, the remainder to be divided equally between the county and the city. There was fear, however, that the original provision would be too burdensome on some of the property owners.

North Dakota Engineers Fix Schedule of Minimum Charges

A schedule of minimum charges fixing the value of full professional services, with supervision of construction, at not less than 6 per cent of the final cost of the work, was adopted by the seventh annual convention of the North Dakota Society of Engineers held Feb. 4 and 5, at Minot, N. D. For surveys and similar work a minimum charge of $10 per day with necessary expenses was fixed.

The subject of engineering ethics and fees was thoroughly canvassed and a code of ethics similar to that recently adopted by the American Society approved.

It was decided not to push the plan recommended without success last year to the State Legislature for licensing land surveyors.

The members visited the plant of the Northern Briquetting Company of Minot, which is believed to be the only commercial plant yet constructed for the manufacture of briquettes from lignite coal. This plant has been in successful operation about a year.

Strenuous Fight Being Made for Ohio Conservancy Act

Last week the Ohio capitol was the scene of an intensely interesting hearing, in which the people of the Miami Valley fought strenuously for the retention on the statute books, unamended, of the Vonderheide conservancy law, passed last year, and which has been under test in court proceedings ever since. Bills have been introduced in the Legislature forbidding the construction of reservoirs for flood prevention purposes, and making such other modifications of the conservancy act as would make it practically null and void. Petitions signed by over 100,000 people were offered as part of the evidence of the desire of the residents of the Miami Valley to keep the present law on the books without change. No action has yet been taken upon the opposing bills.

News of Engineering Societies

The Brooklyn Engineers' Club at its meeting Feb. 18 heard an informal talk on Polar and Equatorial Reminiscences by Anthony Fiala.

The Engineers' Club of Virginia, Minn., was addressed at its meeting Jan. 29 by D. E. Carlton on the subject of "Accident Prevention in the Mesaba Range Mines."

The Vancouver Branch of the Canadian Society of Civil Engineers held its regular meeting Feb. 4. An illustrated paper was presented by R. W. Ford on "Ancient and Modern Gas Manufacture."

The St. Louis Engineers' Club held a joint meeting Feb. 10 with the American Institute of Electrical Engineers, which was addressed by J. A. Osborne on "Special Industrial Application of Electricity."

The Engineers' Society of Western Pennsylvania at its monthly meeting held Feb. 16 heard an illustrated paper on "Rapid Transit Problems in Cities," by Prof. George F. Swain, president of the Boston Transit Commission.

The Engineers' Club of Trenton, N. J., held its regular monthly meeting Feb. 11. Prof. Douglas W. Johnson, of Columbia University, delivered an illustrated talk on the "Topography of Western Europe and Its Influence on the Campaign in France."

The Engineers' Club of Memphis, Tenn., at their meeting held Feb. 10, inaugurated the following officers elected at the last annual meeting: President, J. H. Weatherford; vice-president, E. H. Bowser; secretary-treasurer, C. C. Pashby; directors, H. S. Gladfelter, John McCleary, F. G. Proutt, C. K. Chapin, H. N. Pharr and W. M. Gardner.

The American Institute of Consulting Engineers has announced the results of the election held at its last annual meeting Jan. 19. The following officers and directors for the coming year were elected: President, E. L. Corthell; vice-president, Charles Sooysmith; secretary and treasurer, Frederick A. Molitor; directors, Allen Hazen, George Gibbs and Charles E. Lucke.

The San Francisco Association of Members of the American Society of Civil Engineers held their regular bi-monthly meeting Feb. 19. The newly elected officers—A. M. Hunt, president for the ensuing year, and M. C. Couchot, vice-president for the ensuing two-year term—were inaugurated. E. T. Thurston, Jr., and P. E. Harroun, secretary and treasurer, respectively, have been re-elected for two-year terms. The plan for redistricting the National Society was considered.

The Indiana Sanitary and Water Supply Association has arranged an elaborate program for its eighth annual meeting, to be held at Indianapolis Feb. 23 and 24. Among the papers to be presented are the following: "Lawn Sprinkling Regulations," by Jerry O'Shaughnessy, superintendent of waterworks, Columbus, Ohio; "Treatment of Industrial Wastes," by Langdon Pearse, engineer of the Sanitary District of Chicago; "Stream Sanitation," by Earle B. Phelps, United States Public Health Service, Washington, D. C.; "Waterworks Economies," by Prof. R. L. Sackett, of Purdue University; "Going Value," by Leonard Metcalf, of Boston; "The Great Lakes in Their Relation to Typhoid Fever," by Taliaferro Clark, United States surgeon; "The Indianapolis Experimental Sewage Disposal Plant," by C. H. Underwood, city chemist, Indianapolis; "Water Purification," by W. H. Durbin, Evansville water department, and "Experiences in Treating Surface Water for Algæ," by W. S. Cramer, superintendent of the Lexington (Ky.) waterworks.

Personal Notes

F. R. Charnock has been reappointed city engineer of Medford, Mass.

B. L. Dorman has been reappointed city engineer of Vancouver, Wash.

F. W. Proctor has been reappointed city engineer of North Adams, Mass.

Robert J. Whittaker was recently elected highway engineer of Marion County, Maryland.

A. G. Wulff has opened an office as consulting engineer in the Provident Bank Building, Cincinnati.

A. B. Hayes has been reappointed county engineer in charge of road work at Fort Worth, Texas.

Stanley Macomber, city engineer of Centralia, Wash., who recently finished the construction of a new gravity water system at that city, has resigned to take up work in San Francisco.

H. S. Morse, engineer of the Ohio Institute of Public Efficiency, Columbus, and former sewerage engineer of Cincinnati, has been elected a director of the Cincinnati Bureau of Municipal Research.

Thomas G. Bush has been appointed assistant highway commissioner for the State of Washington. Mr. Bush was formerly manager of F. T. Crowe & Company, a Spokane firm engaged in supplying cement and contractor's equipment.

G. E. Tilt & Company is the name of a new firm located at 90-92 West Broadway, New York City, which will engage in engineering and contracting, specializing in harbor construction. Mr. Tilt was formerly connected with John Monks & Sons.

F. A. Molitor, consulting engineer, of 35 Nassau Street, New York, has been retained by W. Cameron Forbes, receiver of the Brazil Railway, to make an examination and report of the company's lines. He will be absent from this country for four or five months.

Charles Gilman Hyde, of the University of California, and George H. Wilhelm have been retained to assist Frank C. Miller, city engineer of Sacramento, Cal., in passing upon plans for a high-pressure water system, which will cost upwards of a million and a quarter dollars.

J. B. Lippincott and M. M. O'Shaughnessy have been appointed by the city of San Diego, Cal., to review the available water supply and investigate additional developments proposed for that city. Mr. Lippincott was formerly assistant chief engineer of the Los Angeles Aqueduct.

J. W. Fletcher has been appointed engineer in charge of valuation, construction, betterments, inspections, tests and standards of the Carolina & Northwestern Railway at Chester, S. C. Mr. Fletcher was formerly roadway superintendent at the same points. His former position has been abolished.

A. E. Holcomb, manager of the Chicago office of the Clyde Iron Works, has resigned, effective March 1. Mr. Holcomb has purchased an interest in the C. W. Rood Construction Company and the Rood Manufacturing Company, of Grand Rapids, Wis., and will become general manager of both of those companies.

W. C. Armstrong, engineer of bridges for the Chicago & North Western Railway, has been appointed chief engineer in charge of the new union station which is to be constructed at St. Paul, Minn. Mr. Armstrong, it will be remembered, had charge of the design and construction of the recently completed Chicago terminal station of the Chicago & North Western Railway.

W. J. Fairbairn has recently been elected city manager of Big Rapids, Mich. Mr. Fairbairn, who is a graduate of the University of Michigan, began his engineering career under the Board of Water Commissioners of Detroit, where he reached the grade of assistant engineer of construction. More recently he has been engaged in an engineering and contracting business at Springfield, Ohio, with a firm of Sieverling & Fairbairn.

Leonard C. Wason, the newly elected president of the American Concrete Institute, has been president of the Aberthaw Construction Company for twenty years. His company has built some of the largest structures of concrete, including the Harvard stadium. He is the author of the "Engineer's Handbook of Reinforced Concrete," and is a member of the American Society for Testing Materials and of the American Society of Civil Engineers.

Charles L. Fish, who is to take up the secretaryship of the American Concrete Institute in an executive way, was graduated from Worcester Polytechnic Institute in 1900. For some time he was employed by Milliken Brothers in the engineering and sales departments. Later he was employed as a construction and sales engineer by Tucker & Vinton, of New York. He comes to the Institute from Emerson & Norris, manufacturers of artificial stone.

A. W. Newton has been appointed assistant to the president of the Chicago, Burlington & Quincy Railroad with jurisdiction over all lines of the system and with such duties as may be assigned to him by the president. Mr. Newton has been with the Burlington since 1903 and since 1907 has been general inspector of permanent way and structures on the staff of the operating vice-president at Chicago. Since Jan. 1, 1914, he has also been chairman of the committee on Federal valuation, which duties he will continue in his new position. Mr. Newton is also a member of the engineering committee of the president's Conference Committee, which is co-operating with the government forces on valuation matters.

H. M. Hope, for the past four years assistant engineering manager of the Stone & Webster Engineering Corporation, Boston, will open an office March 1 as consulting electrical and mechanical engineer at 141 Milk Street, Boston. Prior to his connection with Stone & Webster Mr. Hope had an extended experience in design, construction and operation with the Chicago Edison Company, the North Shore Electric Company of Chicago and other public utilities. His work with Stone & Webster has embraced numerous investigations, appraisals and reports on properties in many parts of the country, and he has had charge of the design of a number of important transmission lines and power plants.

Hiram N. Savage concluded on Feb. 1 his connection with the United States Government as consulting and supervising engineer to the U. S. Geological Survey, Bureau of Arid Land Reclamation Service. Work done heretofore in Mr. Savage's office will now be handled in the office of the Secretary of the Interior at Washington. Press reports state that Mr. Savage will locate at Billings, Mont., and devote himself to private interests there. After considerable engineering experience in New England and the South, Mr. Savage in 1890 became chief engineer of the San Diego Land and Town Company of California, for whom he designed and built the Morena, Barrett, Lower Otay, Upper Otay and Chollas Heights Dams. He was later engineer in charge of the Sweetwater dam, and consulting engineer for the Sweetwater Company, the Southern California Mountain Water Company and their allied interests. While in the Reclamation Service, Mr. Savage was one of a board of four engineers which passed finally on all irrigation plans of the U. S. Geological Survey.

Obituary Notes

Arthur J. Reid, formerly a civil engineer of Port Huron, Mich., died Feb. 3, in California. Mr. Reid was one of the pioneer railroad builders of Michigan, and was connected with the construction of the old Port Huron & Northwestern railroad.

A. L. Walters, former superintendent of streets of Seattle, died Feb. 8 at his home in that city. He engaged in the contracting business in Seattle from 1889 until 1902, when he was first appointed to the position of superintendent of streets.

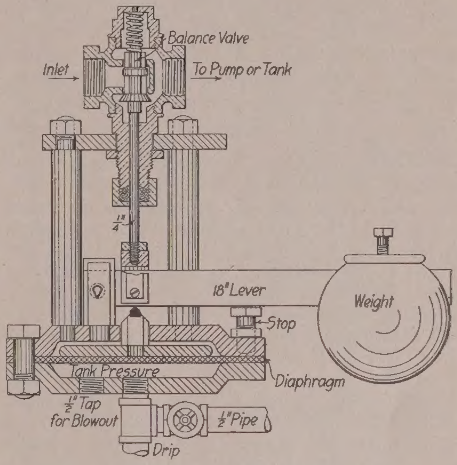
Civil Service Examinations

Examinations Previously Announced

Date.		See Eng. Record
Feb. 23-27	Assistant engineer and draftsman, Philadelphia	Jan. 30
Feb. 24-25	Hull draftsman, United States	Jan. 30
Feb. 26-27	Engineering draftsman, California	Feb. 6
Feb. 27	Junior highway engineer, assistant highway engineer and draftsman, Illinois. Junior assistant engineering department, chain man and inspector of construction, New York	Feb. 13
March 2	Designing engineer, United States	Feb. 6
March 10	Aid, Coast and Geodetic Survey; Computer, Coast and Geodetic Survey; copyist topographic draftsman, departmental service; junior engineer draftsman; topographic draftsman; surveyor, Philippine service; superintendent of construction, supervising architect's office; United States	Feb. 6
April 14	Civil engineer and draftsman; copyist draftsman, Navy Department; mechanical draftsman, Panama Canal Service; ship draftsman, Navy Department; topographic draftsman, Panama Canal Service; engineer, Indian Service; United States	Feb. 6

New Altitude Governor

A new altitude valve or governor, manufactured by the Kitts Manufacturing Company, of Oswego, N. Y., is shown in the accompanying illustration. It may be installed on the pump and use the pressure of the discharge of the pump against the bottom of the diaphragm to control any height of water. This may also be installed in a supply line going to a tank. The 4 or 6-in. supply line might run to a tank a mile from the pumping station, in which case this valve is put into the ground in the manhole near or underneath the tank, and the height of the water, which gives the static pressure on the bottom of the diaphragm, controls the opening and closing of the valve.



LEVER ALTITUDE VALVE

Float valves are commonly used in the tops of railroad water tanks. In the winter time if the float freezes into the ice, the device is made useless. This valve, being installed in the ground in a manhole, is always accessible and under control. The little ½-in pipe line running to the bottom of the tank to get the water pressure must, of course, be protected from frost. A ½-in. hole is tapped in the bottom of the diaphragm pot so that from month to month, or as often as required, the pot may be blown out, in order to keep the rubber diaphragm resilient.

New Centrifugal Machine for Use in Paving Laboratories

The Dulin Rotarex is the name of a centrifugal machine, designed for extracting bituminous aggregates, recently brought out by the Westinghouse Company. This machine is intended for use in analyzing paving compounds, such as bitulithic, macadam and other surface mixtures. It is claimed that samples can be separated and physically analyzed with the help of this machine in six minutes, which would allow paving work to be tested as it was put in, by analyzing samples from time to time at the point of construction. The machine is fitted with a speed-changing switch to accommodate it to various mixtures.

Cloth Cement Sacks at 20 Cents a Barrel

A cloth cement sack which costs only 5 cents a sack, or 20 cents a barrel, and which therefore does not have to be returned, has been developed by the Universal Portland Cement Company and will soon be on the market.

Great trouble has been experienced in getting the small retail consumers to return the expensive cloth sacks now in use. On the other hand, cement shipped in paper is subject to considerable loss in transit due to the weakness of the container. The sacks now developed have roughly six times the strength of paper, and can stand one trip and still be of as much use to the consumer as empty sacks as the old 10-cent cloth sacks. The difference in price between these and the old cloth sacks, therefore, makes it possible to charge the small consumer outright for his package, as is done in selling other products, and still to give him value received for his money, while no one has to stand a loss for unreturned sacks.

Mixing and Placing Concrete with High Pressure Steam Gives Dense Product at Low Cost

The machine illustrated herewith mixes concrete which weighs more than 170 lb. to the cubic foot, according to a paper recently presented at the annual convention of the American Concrete Institute at Philadelphia by Harold P. Brown. Superheated steam at from 75 to 80 lb. pressure is turned into the mixing chamber while the concrete is being thoroughly mixed by mechanical means. The mixture is then discharged through an outlet, and a fresh supply of superheated steam takes it to the form at high velocity through a special hose. This hose has no metal exposed at the couplings, is lined with a special grade of rubber, and is provided with a nozzle opening which can be instantly increased to the diameter of the hose in case it is plugged. It is said that sections of the hose have been used for a year without being worn out. Where steam cannot be used because of the conditions, superheated compressed air is said to give results almost as good. As will be seen from the accompanying cut, showing a plant where steam is supplied from a locomotive through a reducing valve, the superheating effectively prevents condensation of water in the stream of concrete being delivered from the nozzle to the point of work, and enables the workman to see the face upon which he is playing the stream.

It is said that the superheating produces a concrete of considerably increased strength, while the force with which the mixture is applied gives it great density. A thin slab placed in this way has been found to be waterproof under high pressure. When the amount of water is properly regulated very little concrete is lost by falling from the working face, and sections 1 ft. in thickness have been placed in one operation on vertical walls. One of the photographs shows this machine at work repairing a concrete retaining wall on the Delaware, Lackawanna & Western Railroad at Newark, N. J.

The No. 3 machine, which mixes a 20-cu. ft. batch and places from 150 to 180 cu. ft. of concrete per hour, will mix and place concrete with a labor and fuel cost of about 50 cents a yard. The smaller No. 2 machine which was used on the work for the Lackawanna railroad placed concrete for something under 80 cents a yard. One of the first experimental machines of this type was used to coat about 6000 sq. ft. of structural steel with from 2 to 6 in. of concrete for the New York Central Railroad. This work proved very dense and hard, and it is said no cracks have yet developed in it. Many uses are suggested for the product of this machine, such as lining irrigation ditches and canals, fireproofing frame buildings and resurfacing old pavements. It has been found that by building up a 1-in. slab of this concrete against a smooth steel plate a surface is produced next to the steel which is almost polished. A suggestion made by Mr. Brown is that slabs of this kind can be made in the yard and set with the smooth side out in place of the wood now used for the face of concrete forms. After the form has been filled with concrete, these slabs would remain to make the surface of the finished work.

Business Notes

William F. Gurley, president of W. & L. E. Gurley, Troy, N. Y., makers of surveying and water-measuring instruments, died Feb. 17 at Atlantic City, N. J.

Blaine S. Smith has been appointed general sales manager of the Universal Portland Cement Company, succeeding B. F. Affleck, who has been elected president.

The Pelton Water Wheel Company has engaged E. M. Breed as district manager, with headquarters at Vancouver. Mr. Breed has been district manager of the same territory for the Canadian Allis-Chalmers Company, Ltd., for the past eight years.

Trade Publications

The following companies have recently issued trade publications:

The American Cement Machine Company, Inc., Keokuk, Iowa. Specification and price list, 8¾ x 11½ in., 16 pages, illustrated. Dealing with Boss lightweight and Mando mortar and plaster mixers.

Sandusky Portland Cement Company, Sandusky, Ohio. Catalog, 7 x 9¼ in., 32 pages. Medusa white Portland cement and its uses, with illustrations showing some recent constructions on which it has been employed.

Wallace Supplies Manufacturing Company, 412 Orleans Street, Chicago, Ill. An eight-page leaflet presents in brief form descriptions and data relative to bar bending tools and parts.

Gardner Governor Company, Quincy, Ill. Circulars P-3 and A-C 6, each 6 x 9 in. Deal with Gardner duplex steam pumps, including plunger pumps and horizontal duplex air compressors respectively. The descriptions are very thorough and each catalog well illustrated.

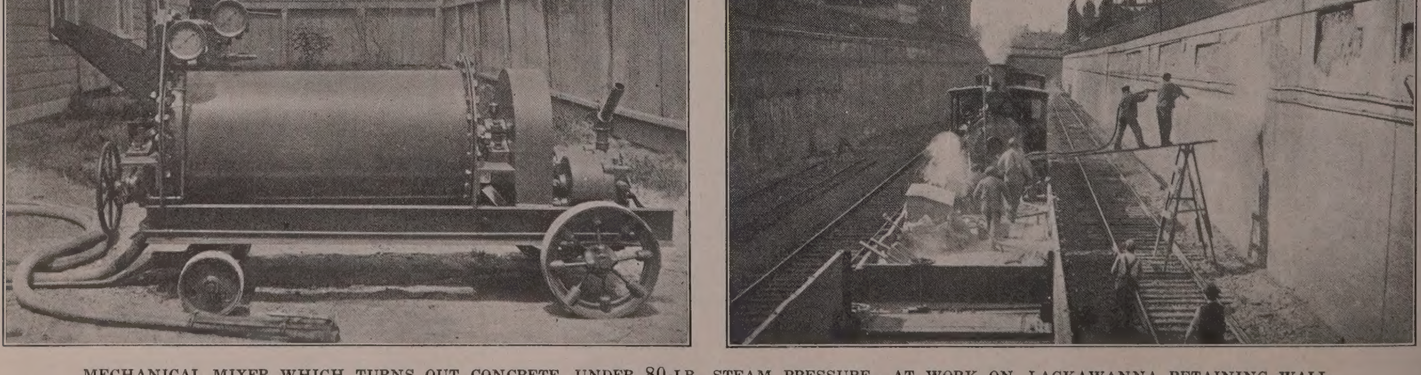
Gas Engine & Power Company and George L. Seabury Company, Con., Morris Heights, New York City. Catalog 10, 48 pages, 6 x 9 in., illustrated. The Seabury safety water tube boiler, which is adapted for power development for pile driving, dredging, asphalt plants, etc.

B. F. Sturtevant Company, Boston, Mass. General catalog 195, 6½ x 9 in., 115 pages, illustrated. Describes briefly in text and table the standard line of Sturtevant products, including all types of fans, engines, turbines and motors. The tables enumerate the capacities of fans at various speeds, the horsepower developed by the engines, turbines and motors and the overall dimensions of each line of apparatus.

Troy Wagon Works Company, Troy, Miami County, Ohio. Book 1 on Troy truck trailers, 5 x 7 in., 16 pages, illustrated, presenting matter descriptive of the Troy trailer, and also performance curves and a table of ton-mile costs. The company has also issued two illustrated mailing folders containing brevities concerning these trailers.

The Barber Asphalt Paving Company, Iroquois Works, Buffalo, N. Y. Folio catalog, 8 x 10 in. Illustrated with inserted photographic reproductions and miniature prints. Descriptive of the semi-portable bituminous mixing plant. There are also inclosed loose insets illustrating the Iroquois double-drum dryer and a small portable asphalt mixing plant. Another catalog, 8 ½ x 11 in., contains information on Iroquois road and street paving machinery, such as rollers, kettles, miscellaneous tools, as well as mixing plants and dryers. A descriptive pamphlet, catalog 21, and a folder each treat of the important supplies for street and road building, covering sundry articles, as broomes, dippers, smoothers, tampers, etc. Both are illustrated.

United States Cast Iron Pipe & Foundry Company, Burlington, N. J. Cloth, 9 x 11 in., 222 pages.—This is a publication of unusual value, being more a handbook for users of cast-iron pipe and pipe fittings than the usual commercial catalog. The first seventy pages are devoted to an introductory descriptive section covering the history of water pipe, to types of joints, service rendered by cast-iron pipe, high-pressure fire systems, submerged lines, cast-iron pipe for gas service, other uses of cast-iron pipe, cast-iron pipe versus other types of pipe, protection of mains and experience with different kinds of jointing material. In this portion of the book there is much very valuable material principally that on types of joints and joint material. The remainder of the volume is devoted to tables of dimensions and weights. These are included under the following heads: American waterworks specifications, bell and spigot water pipe and fittings, flanged pipe and fittings, threaded cast-iron pipe, high-pressure bell and spigot pipe and fittings, high-pressure flanged pipe and fittings, cast-iron bell and spigot service pipe, flanged pipe and fittings for refineries, American standards for flanges and fittings, American Gas Institute specifications, bell and spigot gas-pipe and fittings, flanged gas-pipe and fittings, plain end pipe, useful tables. The tables in the last section include those on flow of water in cast-iron pipe, friction heads for elbows, commercial pipe sizes for fire streams, volume of tanks and cisterns per foot of depth, rate delivery of water, decimal and metric equivalents and a group of tables valuable to the gas engineer. In all cases the tables are very complete, giving all dimensions, thicknesses, weights, etc., of value in estimating and laying out piping systems. The book is exceptionally well printed, the large page allowing ample display, so that the tables are inviting and do not impose the eye-strain quite usual in tabular matter of this sort.



MECHANICAL MIXER WHICH TURNS OUT CONCRETE UNDER 80-LB. STEAM PRESSURE—AT WORK ON LACKAWANNA RETAINING WALL